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PHYSICAL ASPECTS OF CITY PLANNING

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CITY planning involves the whole structure and life of a municipality. Although no plan is physical *or* socio-economic singly, but always *both*, analytical clarity often necessitates the separate treatment of different aspects in order to understand the complex whole more adequately. This paper concentrates on physical urban planning.*

Physical factors are those which are inherent in or emanate most directly from the facts of the three-dimensional world: air, water, land, vegetation, earth structure, space, and "physical" man. They contrast with socio-economic considerations inherent in or emanating most directly from man the psychological and social animal: patterns and trends of individual and group behavior and organization, institutions of government and private enterprise, monetary systems, and the like. The two polar points of view are, of course, inextricably linked, and fuse in the middle ground of joint effect and combined consideration which underlies truly comprehensive planning.

CATEGORIES OF PHYSICAL FACTORS

To simplify their exposition, physical factors are divided into three general categories: 1) long-range, world-wide or continental in scope, by-and-large less definite in their implications; 2) medium-range, regional or national, and more definite; and 3) short-range, local, specific and quite definite in their effects.

1. Long-range

All of man's activities are perforce conditioned by the cosmic behavior and geological structure of the globe on which he resides, its climate and weather, and the many features of its surface configuration and sub-surface formation which influence both the place and manner of his living. Climatic changes are taking place, natural erosion is very slowly wearing down and levelling the terrain, the types and quan-

* The terms city, urban, municipal, and town planning are used interchangeably. Footnote references are grouped at the end of this discussion, as they are either substantiative or sources of further information.

tities of natural vegetation are in flux, and there are alterations under way in the earth's crust.[1] Such long-range physical influences are as yet either so unresolved or involve such vast cycles of time—as compared with the chronology of cities—that their greatest importance for town planning lies in their function as roots for deductions of more immediate relevance. Thus, theoretical geophysics and empirical evidence combine to make possible an interpretation of the geologic substructure of the earth. This in turn permits a determination of underground conditions for various construction operations such as tunnelling or dredging, or the location and character of sub-surface water and mineral resources. On the other hand, an examination of past trends and probable future changes in the significance of geographical position from a world or continental viewpoint, is of direct relevance for such ancient and dominant municipalities as London, Rome, Peking, or Cairo, and lusty newcomers like New York and San Francisco.

Such geographical evaluation constitutes the furthermost practicable backdrop of city planning consideration, the longest view which exerts at any given time a quantitatively slight but qualitatively important orientation to the best urban plans.

2. *Medium-range*

The second general category is composed of physical factors of medium-range, regional or national, and more definite implication. Within a region, constant physical change is under way; soils are modified by climatic variations and changes in land use, man-induced erosion accelerates, and the types and populations of plant and animal life shift. These trends affect agriculture and thereby the warehousing, processing, or retail sales activities of cities and towns in farming areas, the watersheds and rivers from which many communities derive their domestic water supply, or the occurrence and severity of floods and silting downstream. The community drawing its municipal water from a river subject to growing pollution must anticipate rising costs of purification and the possibility of having to find and tap a new source of supply. Since the channels of meandering and silt-laden rivers undergo gradual change, the bordering town may need to determine the desirability and feasibility of redirecting such natural forces, to forestall the results of their being left unhindered.

What is the probable role of the city within its region? What are its potentialities as to function, size, and character? These are difficult questions to answer, but a present policy based on the best information obtainable and the wisest assumptions that can be made is a necessary part of the planning process. Geographic facts and clues are at hand, and empiric theory provides additional insights. The wholesale and retail trade areas of a municipality can be delineated as an element of economic potential; or for example, it has been found that smaller rural trading towns in undifferentiated country tend to evolve as local centers and sub-centers in a more-or-less uniform pattern of spatial distribution.[2] Progress in methods of analysis foreshadow more reliable projection of the type and intensity of probable activity in a region, an important foreground for planning by cities of the area.

Special physical circumstances are significant. Cities favorably located on major transportation routes, situated as the focus of a distinct hinterland, or otherwise enjoying an advantageous geographical position are likely to maintain a development proportional to that of the next larger determining physical and socio-economic entities. Planning for a municipality is clearly related to the prospects of those broader-scale, regional or national phenomena and enterprises on which its spatial form and economic condition may depend to a greater or lesser degree. A town primarily a recreational satellite for a large city must relate its planning not only to the income level and preferences as to type of activity of those who use its facilities, but also to the physical forms of transportation and particular routes they employ. Or calculation of the extent, accessibility, and probable rate of depletion of a mineral resource will mark a crucial point in time for the purely mining community. It may call for planning the least disruptive decrease in the town's activities and size, and perhaps its eventual disappearance. Organized foresight is not restricted to growing towns; it is equally beneficial to the contracting community, and every nation or region includes both contracting and expanding organisms.

These exemplify medium-range considerations, important although their effects belong to some future time, or may influence the community indirectly through one or more intermediate causations. Few of these physical factors are immutable; most are subject to modification at an economic cost; some are indeterminate. But together they constitute the physical portion of an evolving context within which realistic town plans must be composed.

3. *Short-range*

Short-range physical factors, operative within the city boundaries or metropolitan region, comprise the third division. Their influence is specific and clearcut. Water courses, steep valleys, main railroads and highways act as barriers or separators. Cross-connection over the first two is restricted and localized by the difficulty and expense of bridging; the dangers imposed by traffic on the latter two impede vehicular and pedestrian crossing, unless special structures are built which in turn funnel circulation to particular points. Local weather (air movement, precipitation, or temperature) is of widespread import; it affects the location of an airport, the form of drainage facilities, the strength requirements, orientation, and design of buildings, or provisions for snow removal. Sub-surface or surface conditions may require special foundations and construction, or a certain type and arrangement of underground utilities. Especially rigorous building codes are called for in areas of frequent earthquakes. Gradients influence the location of railroads, streets, utilities and buildings. The presence of areas of highly productive soil or attractive bodies of water pose questions of best relative land use: truck farming versus built-up in the first instance, recreational or residential versus industrial in the second.

More general effects, to a large extent the result of shorter-range physical factors, are also present. For example, a study of a number of sizeable American munici-

palities indicates that high-rent, urban residential neighborhoods tend to develop and move: within one or more sections; from a point of origin along established lines of travel towards another nucleus of buildings or trade centers; towards higher ground free from floods and along non-industrialized waterfronts; towards the homes of community leaders; in the same direction for a long period of time.[3] Retail business tends to locate on flat land and to seek level ground in its areal expansion.[4] Historical study of cities supports a principle entitled *"la loi de la persistance du plan."*[5] Urban patterns persist with a remarkable and often subtle tenacity. To accomplish major changes in a city's basic circulatory net or land uses is extremely difficult; even destroyed cities rise from the rubble with the image of their previous pattern clearly reflected in the rebuilt organism. A change in basic arrangement is rarely made except through progressive steps comprising a long-range plan.

OPERATIVE CHARACTERISTICS OF PHYSICAL FACTORS

It will have been observed that many physical factors are germane to all three categories; they may be clearcut impulsions for the immediate future, and also pertain to longer-range concerns. Each category relates to the others; but each exerts its primary influence with respect to a general period of time in the projection into the future involved in a continual, periodically revised city plan. Further, there are three ways in which these physical influences operate on municipalities and planning: 1) cumulative; 2) over-all; and 3) a combination of the two. The consequences of sloping terrain are illustrative.

1. *Cumulative (Vertical)*

√ Slope is a major determinant in the location of structures. There are, for example, practical limits to the feasible gradients of highways, for both type of construction and cost are related to the degree of slope. Roads with considerable gradient normally require more cut-and-fill movement of earth in their construction, a hard surface to reduce erosion and provide traction, and more extensive provisions for drainage. Highways are therefore more curving in irregular terrain, in order to maintain a lower gradient by "following" the contours. Their winding path in turn calls for the safety provisions of more numerous guard rails, more elaborate road marking, the cutting back of bordering banks to provide an unobstructed view for safe driving, stopping places for the motorist off the roadway, and protection against rock slides. These in their turn increase road maintenance. The initial or "originating" influence of slope on some element of community form accumulates through a succession of repercussive effects.

2. *Over-all (Horizontal)*

Unlevel topography also operates on towns and cities in an over-all manner. It is related to erosion, the location and type of structures, the location and use of open land, the probable development and movement of certain districts within the community, expenditures of human and vehicular energy, the psychological and aes-

thetic impact of the terrain, the presence and extent of subsurface geologic depositions and underground water, local air currents and other weather characteristics, and the spatial disposition and duration of shade, shadow, and direct insolation. The fact of slope creates simultaneous forces on diverse aspects of urban environment.

3. *Combined*

By a combination of these cumulative and over-all effects, slope exerts a complex chain-reaction throughout the community. The sum-total pattern of all "vertical" and "horizontal" forces of physical nature operating together varies with each town and city; there are, however, certain effects—of which slope is one—which are of widespread import. The significance of different physical factors for the community is a function of its history, interrelationships with larger contexts, present form, constituent socio-economic forces, and planning objectives. All are conditioned by the general value system of the culture to which the community belongs. Thus, the value attached to speed in the United States calls for highways designed for faster travel than is wanted by many cultures; this means, of course, that the influences of physiography on highways are greater in this country.

IMPACT OF MAN ON NATURE

So far, the effects of physical factors on man have been emphasized. Equally vital is the impact of man on nature, and his increasing capacity to modify or overcome physical conditions. Throughout the centuries, man's activities have reacted upon nature. In clearing land he has upset the ecological cycle by modifying the environmental requirements of certain vegetation and animal life, augmenting erosion, and inaugurating new land uses which accelerated natural change and introduced new physical characteristics in these areas. Water and soil pollution occasion new man-induced alterations in the natural scene, and thereby generate additional considerations for planning. In subtle fashion, man supplements nature with fertilizer, produces strains to counteract environmental adversities or hasten evolution, or devises means of replenishing underground water basins. He can now modify the weather under certain conditions, and the power is his to bomb the municipality to at least temporary extinction.

What were at one time effective barriers to transportation have been surmounted by steamship, railroad, motor vehicle, aircraft, bridge, ferry, tunnel, dam or dredge. Man is not bound to natural drainage or local water supply; he can create urban landscaping in short order, and build despite highly unfavorable foundation conditions. Modern earth-moving equipment has greatly magnified his capability to level and form terrain. New sources of power may make possible a further deconcentration of urban patterns.

Such achievements permit man to shape the physical city according to his desires to a greater and greater extent, and in lessening time. But clearly this is possible only at a socio-economic and material cost. Surmounting physical limitations

requires resources which could be otherwise employed, and relates to the basic planning objective of obtaining the best relative utilization of the total resources available, in the interest of the community as a whole. To the extent that activities and structures can be adjusted in terms of other needs and values *to make use of* existing physical conditions and forces, or minimize their adverse effects (rather than overcome them in direct conflict), an optimum use of community resources is forwarded.

SPATIAL ARRANGEMENT AND THE CITY

The physical factors discussed briefly in the previous section have a bearing upon the location and disposition in space of the productive elements, centers of activity, and various districts of a city: industry, commerce, finance, business or residence. These in turn act as spatial lodestones to closely related enterprises, or otherwise modify the surrounding area. If a city exists chiefly because of its relation to water transportation, there is a readily understandable concentration of commercial and industrial activity at or near the waterfront. The extractive, processing, and attendant industrial operations of a mining town are very likely to be next to the ore body or in the immediate vicinity. The spatial focus of basic employment in a community primarily a divisional and maintenance point on a railroad is found adjacent to the mainline right-of-way: yards, maintenance and repair shops, equipment manufacturing, storage, icing plants, and other services. Warehousing is normally found in an area of lower land values, nearby manufacturing, commerce or business. Municipalities in general tend to have a main concentration of retail business within the central area, with smaller concentrations toward the periphery of the larger towns. The exceptions which prove such general rules are the result of particular circumstances of local geography, land economics, or personal, as opposed to socio-economic, choice.[6]

Thus, from the founding of the city and throughout its life, there is a disposition of foci for prime activities, established by a combination of physical factors (necessary or desirable spatial characteristics, proximities, or interrelationships), and socio-economic considerations (such as land and operation costs, taxes, or some aspect of human welfare). The arrangement of these main functional elements—the pattern formed by their location on the ground—exerts a directive influence throughout the community. Lines of transportation and communication are called for leading to and between them. Present day traffic congestion and parking difficulties are largely the result of the conflict between the space requirements of motor vehicles and areal concentrations of activity. People, vehicles, and goods compete for a larger share of the limited space available. In large part, these foci determine the use and character of the areas immediately surrounding them, and they influence the general direction and growth of the community as a whole. Some of the outstanding urban problems in the United States today relate to the formation of new foci and the modification of the urban-wide pattern of centralization and spatial emphasis, brought about by the decentralization movement toward the suburbs. In planning for any municipality, the location and efficient functioning of these concen-

trations of activity, the spatial pattern which they form, and their apparent or probable evolution are prime considerations.

Between and around these points and the primary net of movement which they bring into being, subsidiary patterns of secondary streets, alleys, building arrangements, and land use are established. To date, this "interstitial" arrangement has been haphazard in most American cities. Examination of an aerial photographic view of an entire town reveals at a glance some of the results of this lack of spatial planning. The street pattern is seen to have developed in so unorganized a manner that much-needed circumferential routes at the urban periphery are almost nonexistent, and are physically difficult and costly to construct. Insufficient attention has been paid to the interrelation of adjacent subdivisions. The street pattern of a small area may be made up of a half-dozen or more segments, representing various kinds of street patterns (curvilinear, gridiron, rambling), oriented differently, and interconnected without rhyme or reason. Antipathetic land uses are common: heavy industry, residences, and cemetery side by side; or the "ribbon development" of stores along both sides of a main street, which gradually throttles its utility as a traffic artery and produces a bottleneck of congestion for shoppers.

Just as poor layout within the home or institutional group (multiple-apartment project, manufacturing plant, or university) creates maladjustments, so also does poor arrangement on a broader scale exert adverse effects throughout the municipality. Without its own special provisions for parking, a tall office or apartment building clogs the surrounding streets with the parked automobiles of its occupants. Failure to provide off-street facilities for loading and unloading further delays vehicular circulation. The size, orientation, spacing and particular arrangement of buildings determine if one lies in the area of shadow cast by another, whether sufficient direct sunlight permeates the area, or if natural ventilation is maximized. The size of city blocks is significant. Small residential blocks require more linear feet of streets in proportion to lot area than are needed for access, and streets are often the same dimensions and type despite great differences in function. Frequently, no attempt is made to exclude through traffic from purely residential streets and channel it to an arterial route, designed for faster-flowing traffic and forming part of an urban-wide system of primary and secondary circulation.

Besides their type and condition, the arrangement in space of individual urban structures is a primary determinant of the three-dimensional environment as created by man—with its many implications for the individual and social group. The relationship between crime, delinquency, and morbidity rates and dense, overcrowded and dilapidated structures has been demonstrated.[7] Land use and traffic are directly interconnected. A focal area of heavy traffic attracts business; the erection of a tall office building or store in turn engenders more traffic. Each fact of spatial environment may have various influences on the community. The new office building will probably require new patterns of commutation for the workers it houses; heightened traffic congestion at its base may call for more traffic policemen, thereby reducing the number available for other duties without increased appropriations;

or the traffic may transform the street into a "barrier" of danger between the children of a residential area and the school they attend.

The influences of areal arrangement may be subtle and indirect. A number of single-family houses of the same size and style are grouped about a cul-de-sac (dead-end or turnaround) street, extending at right angles from another road. All the homes front on the cul-de-sac except the last two; these face the road from which it extends. Because they are turned spatially in a direction ninety degrees different from the other houses, and do not therefore form part of the common focus of the group, a feeling of "not belonging" is more likely to be experienced by the occupants of these two homes. This is reflected in more frequent changes in occupancy for these end houses which are less well integrated into the neighborhood pattern of natural interconnection and social focus on the ground.[8] The outstanding role of physical arrangement and design in the creation of an aesthetically satisfying and stimulating environment is unmistakable.

The diverse effects of spatial arrangement on urban life comprise one causative interaction. The reciprocal modification of physical form by socio-economic factors is exemplified in the historical development of automotive transportation. Inventive, engineering, manufacturing, financial, and managerial achievement combined over a period of time to make possible the mass-produced motor car. Man's desire for such a vehicle comprised the necessary demand, and the general income level provided the purchasing power. A concurrent physical improvement of roads magnified the usefulness of the automobile and increased demand, which in turn stimulated a gradual redesign of streets and highways to fit the automobile. The profound effects of this process on the three-dimensional characteristics of American cities needs no elaboration; they are to be seen on all sides.

Developments in science and technology such as electric transmission, the telephone, elevator, pipe-line, "bottled" domestic gas, the steel-frame construction of buildings, have modified or extended the feasible ways of organizing urban space. Less tangible factors also exert an influence. The desires of the body politic establish a background for the determination of minimum and desirable provisions for many spatial features and dimensions; room and building size and components, park area, residential lot size, parking provisions, utility requirements, or acceptable walking distances for various purposes. And the underlying value system of the culture forms a basic framework within which the community, in all its aspects, is conceived and planned.

CATEGORIES OF PHYSICAL CITY PLANNING

From the point of view of significance for spatial pattern and physical design, three kinds of town planning can be identified: 1) initial, 2) superimposed, and 3) emergent.

1. *Initial*

In the first instance, no city exists. The site for the town is normally in some form of rural land use, mainly open country with but few structures to be removed

to make way for the new development. Land values are relatively low, and the necessary acreage will have been acquired under single ownership or some form of control through condemnation or long-term lease. Also, the municipality will be built in a comparatively short period of time under the direction of a single or unified organization, and in accordance with one over-all plan and construction program. It should therefore reflect the advantages and opportunities of having been studied, planned, and built as an entity with a minimum of starting limitations. Although physical and socio-economic considerations always define the nature of the best planning solutions, a greater choice and flexibility of solution naturally exists in the case of a new town.[9]

As a type, initial planning may also be applied within underdeveloped sections of a city, and in those unbuilt-upon areas at the periphery where growth and expansion may take the form of whole new neighborhoods. In both situations, greater limitations are involved than is normally the case with an entirely new town.[10]

2. *Superimposed*

The superimposed plan calls for radical change in the form and character of an existing city. It reflects the conclusion that palliative measures applied over a considerable period of time will not suffice to eliminate recognized maladjustments seriously affecting the health of the municipality; surgery is required. Perhaps critical transportation blockages cannot be relieved because the street system is based on the tracks and paths of a far earlier day; or certain areas are so aged, dense and uniformly dilapidated that the scalpel rather than the splint is in order. Accordingly, conformity with the existing layout is minimized insofar as desirable and possible, and a new pattern is developed to provide the basis for a transformation. In view of the considerable demolition of structure, changes in land use, establishment of new rights-of-way, or relocation of activity involved in such a plan, the term "superimposed" is employed because a new pattern will emerge superposed over the old.[11]

3. *Emergent*

Emergent plan describes a more continuous and gradual process, a series of increments directed toward desired urban improvement. Continuing research provides the background for the identification and analysis of goals, problems, needs, and trends. A development or master plan is formulated as a long-range technical specification of objectives, representing the outcome of a schedule of progressive steps. The master plan is adjusted periodically to incorporate new factors and modifications of objective. Shorter-range programs of accomplishment, conforming to the longer-range plan and within the current capacity of the community are undertaken year by year. Thus, this kind of planning emphasizes a continuous formulation in accordance with the constantly evolving scene; "the process itself is the actuality."[12]

These three general types of planning do not comprise distinct categories, but interrelate in various ways. In a sense, the initial plan is one superimposed on

undeveloped countryside. Once a new town is built, it must choose the superimposed or emergent forms of planning (or a combination of the two) for its built-up areas. These last two forms may differ mainly in that the superimposed plan represents more radical solutions applied at longer intervals; it is often the kind of planning required when urban maladjustments are allowed to multiply and magnify over a period of time without the continual remedial action characteristic of emergent planning. In some degree, this latter type is present in all planning.

SPATIAL FEATURES OF PRESENT-DAY CITY PLANS

Examination of outstanding city plans of all three kinds indicates that they have in common a number of spatial objectives and recommendations bearing directly on physical form. This consensus represents an important body of agreement and similar effort; it defines a trend. The extent to which these objectives are incorporated, their priority and precise form, and the way they are to be achieved naturally vary with the particular community and type of planning.

I. Transportation:[13]

1. Organization of community-wide networks of primary roads and railway lines according to radial-concentric systems. In larger cities, radial highways extend outward from a loop about the central business-commercial areas. These are crossed at intervals by circumferential routes of increasing radius, which provide connection between outer sectors of the city without traversing the center-city. A portion of the outermost circumferential route usually functions as a by-pass around the city for interregional traffic. Railroad lines are also planned as a radial-concentric system, although it is usually less complete than the highway pattern.
2. Street and highway design according to function and best contemporary practices; discouragement or prevention of antipathetic use.
3. Prevention and elimination of "ribbon development," especially along present and proposed primary and secondary transportation networks.
4. Adequate space for parking throughout the community, at the various locations where needed.
5. Elimination of on-street or roadside parking in areas of heavy traffic.
6. Designation of primary truck routes through the city.
7. Elimination of unnecessary or duplicative railroad trackage and facilities.
8. Consolidation of terminal facilities.
9. Selection of airport sites for much-expanded air traffic, as close to the city as feasible.

II. Industry:[14]

10. Location of new industry and gradual consolidation of existing scattered industry in particular districts.
11. Special location or isolation of "noxious" industries.

III. Business-Commercial:[15]

12. Development of planned shopping centers, located in outlying areas and serving a general district or several neighborhood units; placed adjacent to but not along arterial streets.
13. Provision by private enterprise, in new construction and development, of off-street parking and servicing within the lot or building.

IV. Residential:[16]

14. Organization of land and structures into neighborhood units, of varying type and extent. The number of persons accommodated in the unit and its area are related to the effective radii for one or more service functions. To date, the elementary school has been the most frequent determinant of size. Neighborhood units are delineated by some form of physical separator, existing (e.g. arterial street) or created (e.g. park strip). A neighborhood shopping center is included.
15. Use of the larger-size "super-block."
16. Avoidance of the highly-regular, gridiron layout of streets.
17. Reduction of population densities.
18. Reduced building coverage on the land; provision of more extensive unbuilt-upon areas about and between buildings.
19. Increased proportion of multi-story, rental, apartment buildings; more public housing.
20. Reduction in the heterogeneity of land-use and types of structures within small areas; grouping together of different or related uses and types.

V. Recreation:[17]

21. Provision of well-distributed neighborhood parks and playgrounds.
22. Design and organization of larger parks and related recreational activity into a city-wide, interconnected system. Parks may serve as separators between neighborhoods, different activities, or land uses.

VI. General:[18]

23. Establishment of a civic center.
24. Location of different institutions with reference to their "market area," accessibility, and other considerations; and with more adequate land area.
25. Adoption or incorporation of desirable or minimum standards for various areal, spatial and physical provisions.
26. A comprehensive zoning ordinance, including: a) reduction in the area usually zoned for business, and avoidance of the type of zoning which allows extended "ribbon development" of business; b) formation of categories in addition to those ordinarily employed (e.g. apartment housing); c) restriction of each zone to a single or several related uses; d) extension of the area covered by municipal zoning several miles beyond the official city limits; e) inclusion of "retroactive" zoning, requiring that certain uses be abandoned within a given time.
27. Subdivision controls requiring that the intended street layout, utility systems, general plans and other specifications of private real estate developments be approved by the public planning body. Prohibition of very small lot sizes, and in general, more liberal areal requirements.

Besides these common features, there are several individual concepts which have had a significant impact on town planning in general. The most influential of these formulates what has been described as the "organic, integrated-neighborhood city." This concept advocates the organization of the municipality into distinct neighborhoods, each with from some four to six thousand residents. These neighborhoods are integrated in that each is divorced from adjacent units by some form of physical separator; and focuses on its own community center containing an elementary school, stores, and other local facilities and services. Other sections of the city (central business and commercial, industrial and manufacturing, district shopping centers) likewise form separate areal entities, each designed for the best operation

of its predominant activities. Neighborhoods and other units are interconnected transportationally, and separated spatially, by a radial-concentric network of primary roads and bordering park strips. The entire urban complex is surrounded by a protective "greenbelt" of open land, reserved for park-recreational and agricultural-rural use. Zoning fixes this over-all pattern of deliberate differentiation. Expansion or contraction of the city is by adding or subtracting whole neighborhood units, or if an optimum urban size has been reached, by starting another town. There are few contemporary city plans which do not in some way reflect this concept, under development since before the turn of the century.[19]

Another scheme calls for the reorganization of a large part of the urban community into tremendous skyscraper structures—widely spaced in extensive open areas devoted to park and recreation, and interconnected by a consolidated grid of fast transportation routes. The lofty structures at the center of the city are devoted to business, commerce, government and related activities, whereas those in the next outer ring comprise huge apartment buildings. At the periphery, there are districts of detached dwellings; industry occupies a special section.[20]

Yet another idea is that the present decentralization movement from cities and the technological possibilities of contemporary science be extrapolated to their "logical conclusion" by creating an environmental fusion of town and countryside. Since five acres of land on the average are alloted to each family, a much larger area is involved than in the ordinary community. A grid of superhighways and lesser routes comprises the transportation backbone (it is assumed each family unit possesses one or more cars); "aerotor" air travel and surface monorails supplement the motor vehicle. Small farms, industries, markets, schools, universities, laboratories, airports, aquaria, arenas, zoos, art centers, and other small facilities are distributed evenly throughout the rurban countryside. In contrast to the concept of a city of great vertical concentrations of activity, here the accent is one of low, extended horizontality and small decentralized functional units.[21]

And lastly, there is the idea of the linear city, made up of zones of activity stretching along both sides of a superhighway. On one side is first a parallel band of dwellings, including schools, nurseries and other residential activity. Commercial activity is concentrated at intervals within this zone. The next zone, on the same side of the expressway and further outward, is devoted to parks containing various administrative, social, artistic and athletic institutions and activities. Beyond is agriculture and open country. On the opposite side of the superhighway is the band of industry, manufacturing, technical schools and related enterprises, served by a railroad along the outer edge of the zone. Beyond the railroad is the countryside. Each zone is separated from its neighbor by a narrow parkstrip, a protective band of open, unbuilt-upon land.[22]

These latter concepts have not exerted the widespread influence of the organic-neighborhood city, but their effects can be seen nonetheless in the thinking of town planners and the form of some contemporary plans.

PHYSICAL ASPECTS AND COMPREHENSIVE CITY PLANNING

As illustrated at the beginning of this discussion, every actual situation in community planning combines physical and socio-economic considerations in inseparable combination. If not at least partly the *result* of socio-economic forces, the facts of physical environment and community form are *comprehended* in terms of cultural and societal values; and they are *evaluated* by economic and social measurement. In one way or another, and to a greater or lesser extent, physical features are by and for people. Ordinarily, maximum room sizes, building heights, lot sizes, or community services, for example, are determined by economic feasibility; on the other hand, minima are set by physiological and social criteria.

Planning the physical environment is planning the socio-economic community at one and the same time. Both direct and imputed costs (initial, maintenance and replacement) may vary tremendously with different spatial arrangements. A shift in the location of some physical element (factory, shopping center, or traffic artery) may mean economic repercussions throughout the city, as well as variation in the character and operational efficiency of the element itself. Economic repercussions signify changes in local valuation, income and expenditure, productivity or stability —each of which is clearly socially meaningful. In one way or another, the location, type, size, orientation and grouping of dwellings and work places both reflect and shape the social community.

Thus, in comprehensive town planning, physical factors and elements (in whole or in part) are of necessity considered in terms of social and economic contributions and costs. Reciprocally, socio-economic study has no reality apart from the ponderables of the three-dimensional world, which are both the social context and the object of economic measurement and analysis.

Recognition of this mutuality is relatively recent. Not long ago, city planning overemphasized physical reconstruction and beautification, almost to the exclusion of socio-economic matters. As a result, such fundamentally unrealistic conceptions were only rarely carried out in part, and most so-called city plans lay unused in municipal archives. Broadly speaking, the more comprehensive approach increasingly characteristic of present-day community planning represents a general direction of more productive effort and promises more significant results, for analytical understanding is no longer so seriously delimited.

Specifically, it has meant a number of important changes. At one time, the type and quality of municipal government, the current and potential economic base of the community, industrial diversification, social organization, or public housing were regarded as beyond the concern of city planning. Today, they are illustrative of the diverse aspects judged to be part of the problem and part of the solution. Needless to say, methodologically speaking, this conceptual expansion has added greatly to the technical complexity of urban planning. Whereas at one time, it involved a comparatively simple visualization of physical and architectural reorganization, without concurrent analysis of economic, geographic, social or political de-

sirability and feasibility, now these and numerous other considerations must be taken into account.

Priorities exemplify this new technical complexity and the intellectual challenge it presents. Progress has been made in the techniques of planning for separate elements of a comprehensive plan: traffic, parks and playgrounds, subdivisions, industrial districts or public housing projects and public works. There remain to be developed, however, methods of analysis providing a fuller comprehension of the complex of interrelationships involved in the plan as a totality. Comprehensive community planning includes many considerations, ranging from broad attitudinal or social aspects to highly specific engineering requirements. It is concerned with program elements of disparate nature, some of concrete type involving physical objects and material quantities, others dealing with services or satisfactions less readily measured. Better methods of comparative evaluation are needed, if the relative effectiveness of different alternative expenditures or efforts for particular purposes is to be determined for the whole. In other words, for a given expenditure of money, time and labor for current operation and short- and long-range planning, what techniques can be devised to show more scientifically the optimum apportionment between such diverse activities as new highways, education, housing, fire and police protection, recreation or welfare services—the criterion of "optimum apportionment" being that allocation which maximizes the benefits for the entire complex, in accordance with established objectives. In briefest outline, this describes a difficult technical problem brought to the fore by the more inclusive concept of contemporary city planning.

As a consequence, the number of different specialists participating directly in planning has become more numerous. Not for some time have the larger and more active city planning commissions consisted for the most part of architects, engineers and draftsmen. Now included—besides the planner himself—are the lawyer, statistician, economist, public administrator, geographer, sociologist and general research analyst. Similarly, the commission members themselves and actively interested citizens represent today a much wider variety of occupational affiliations than heretofore.

Another resultant change has had to do with the function and organizational placement of the planning agency within municipal government. It is slowly being recognized that comprehensive planning is not only an inherent and essential activity, but a coordinative function of prime significance. As conceived today, it is no peripheral luxury or merely desirable advisory activity, but a municipal *sine qua non*, with a central role within the structure of city government.

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A SAMPLE STUDY OF THE CALIFORNIA RANCH

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*U. S. Government**

MUCH attention has been focused on the rapid agricultural development of California, but very little has dwelt specifically on concomitant changes in the "ranches" of the state.[1] Such a deficiency also precludes any statistical picture of the present ranchsteads, as well as comparisons of this type of farming unit with those of other American agricultural areas for which information is available.[2] A study of the ranch and ranchstead in a small, but nationally significant, agricultural area was made in the summer of 1949 in an effort to discover some of this information.

THE SAMPLE AREA

The "Oxnard Area" is a coastal lowland, located approximately fifty miles northwest of Los Angeles (Fig. 1). Lying in the southern one-sixth of Ventura County, it embraces the majority of the agricultural land in that political unit.

The fertile loamy soils and gently sloping surface toward the sea classify the area geomorphologically as a delta-fan plain. A strip of sand dunes and bay mouth bars along the immediate coast combine with the small seaward slope (5–15 feet per mile) to produce a drainage problem in the lower portions of the plain. Fan slopes are steeper in the interior sections (50–150 feet per mile). Rolling to roughly dissected hills break off abruptly from the lowland surface at elevations of 100 to 400 feet. Summit elevations in the bordering hill lands range from 100 (Camarillo Hills) to 1800 (Santa Monica Mountains) feet.

Climate is of the cool-summer Mediterranean type. The city of Oxnard has average January and September temperatures of 54° F. and 64° F., respectively. Frequent fogs, brisk ocean breezes, and rarity of frost are also important maritime influences. Precipitation averages 15 inches over the lowland, although a maximum variation of 700 per cent between yearly amounts has been recorded for the 1875–1930 period.[3]

Despite variations, the agricultural history of the Oxnard Area is generally representative of the land use sequence so common to California: cattle, grain, fruit

* Formerly Indiana University.

[1] The continued popular use of the terms "ranch," "ranchstead," and "rancher," rather than "farm," "farmstead," and "farmer," is an interesting cultural overlap of the Spanish-Mexican rancho days. These are common terms in California and are used in both unofficial and official capacities.

[2] No comparisons have been attempted in this paper. They may be obtained by referring to the figures given here and those of other areas as presented by G. T. Trewartha in "Some Regional Characteristics of American Farmsteads," *Annals of the Association of American Geographers*, XXXVIII (1948): 169-225.

[3] Climatological data from U. S. Weather Bureau, and C. M. Zierer, "The Ventura Area of Southern California," *Bulletin of the Geographical Society of Philadelphia*, XXX (1932): 29.

and vegetables, increasing urbanization. Although the lowland area itself encompasses only about 150 square miles, it now ranks nationally among agricultural areas; over one-third of all the lemons and commercial lima beans, and one-tenth of the English walnuts, produced in the United States in 1948 were raised here. Vegetables, oranges, avocados, sugar beets, barley, and alfalfa are also currently important.

FIELD METHODS

Historical records and property maps of different dates give a fair amount of general information on the ranches of the Oxnard Area. The maps, however, do not take into account the many subdivisions of property which were operated by tenants (considered as separate ranches by the U. S. Census Bureau). Almost no ranchstead data was available—a few sketches in a county history and six very general plats in the files of a fire insurance firm. Much of the study thus had to depend primarily upon extensive field work.

All of the approximately 800 Oxnard Area ranchsteads were plotted on a base map through the use of topographic sheets and vertical aerial photographs. Because the time required to visit 800 ranchsteads would have been prohibitive, it was felt that one sample out of every eight would be sufficient to give representative data. To further expedite field work, the ranchsteads to be considered were grouped into strips along public roads (Fig. 1). This was logical since the overwhelming majority of them are found on, or next to, the highway. Fairly equal spacing of these strips and selection of a standard length took into account variances in ranchstead density. An attempt was also made to locate the strips in such a way as to perceive any possible effects of marked local variations or similarities in cultural and physical elements. Thus, for example, strips were placed on the margins of the cities of Ventura and Oxnard to observe any possible effects of urbanization, while another area was located in a coastal section near Point Mugu so as to consider the consequences of strongly alkaline soil.[4] These sample areas were designated by letters, by which ready reference of tabular information to the map could be made.

A list of basic facts concerning the ranch and ranchstead was then made:

1—Rooms in house
2—Owner or renter
3—Ranch size
4—Chief source of income: agricultural or non-agricultural
5—Number of buildings on ranchstead
6—Number of stories in house
7—House type
8—Building materials of house
9—House color
10—Roofing materials of house
11—Barn type
12—Building materials of barn
13—Barn color
14—Barn area
15—Ranchstead area
16—Ranchstead shape
17—Location of ranchstead with respect to public highway

[4] In rural-urban fringes, ranchsteads were distinguished from urban homes by areal isolation of the former. Some ranchsteads were omitted by this process, but the number was negligible.

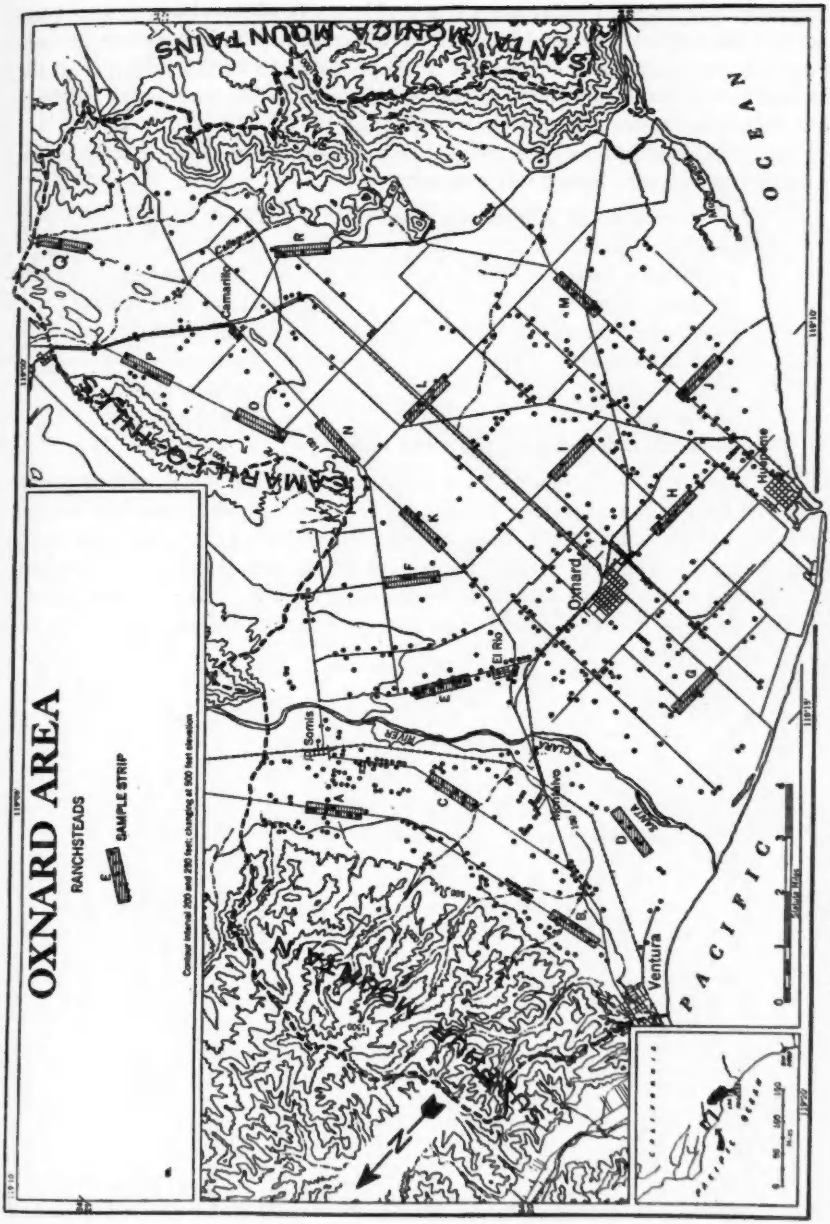

FIG. 1. The distribution of ranchsteads in the Oxnard Area, including samples studied.

Points 1 to 4 involved information that could only be obtained by personal questioning of the rancher. Points 14 and 15 were obtained by superimposing an overlay grid of one-quarter acre units upon aerial photographs of the subjects. If the barn was rather small, and thus sometimes indistinguishable from other buildings in the photographs, size computation was made on the spot.

Point 5 required further subdivision. To ascertain the function of buildings on the ranchstead, another legend was created:

a—Tenant house (migratory tenants)
b—Horse barn
c—Milking barn
d—Feed barn
e—Chicken house
f—Machine shed
g—Workshop
h—Garage
i—Walnut dehydrating plant and huller
j—Tank tower
k—Windmill
l—Home garden
m—Home orchard
n—House yard
o—Cattle yard
p—Chicken yard
q—Windbreak

Vertical columns, each headed by a number designating the particular ranchstead, were then drawn on paper. These numbers coincided with those that marked the ranchstead locations on the overlay mentioned above. Data could thus easily be located on the base map. Along the left margin of each column were numbers corresponding to the items of information desired (1 to 17). The adjacent blanks were then filled in the field. Field data for one ranchstead demonstrates the result of this technique:

	31	32	33	34	35
1	5				
2	R				
3	160				
4	A				
5	5—f-h, i, k, e, l, m, p, q				
6	1				
7	5				
8	F				
9	W				
10	TS				
11	2				
12	F				
13	W				
14	.06				
15	2.5				
16	R				
17	R				

Thus, ranchstead 31 encompasses 2.5 acres, has a rectangular ground plan and

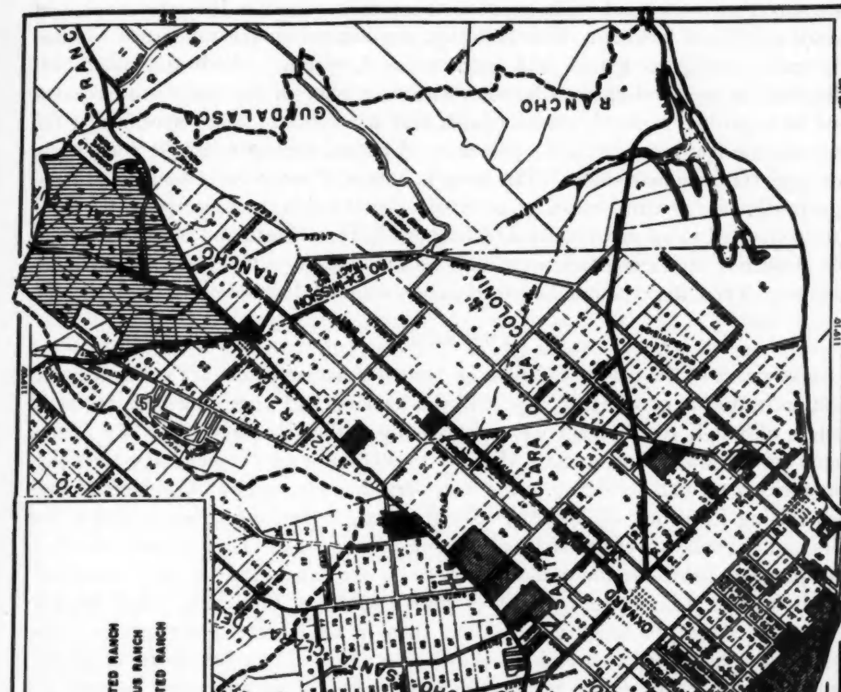

FIG. 2. Subdivisions and shapes of ranches that are owned.

fronts directly on the road. The resident is a tenant, works a 160-acre ranch, and depends chiefly on farming. Five buildings are located on the ranchstead: house, barn—now serving as garage and machine shed, walnut dehydrating plant and huller, tank house, and chicken house. The remainder of the ranchstead is composed of a garden, orchard, chicken yard, and windbreak. More specifically, the house has the features of type 5—one story, 5 rooms, tarpaper shingle roof, white color, and frame construction. The barn is a type 2 structure (wingless, single-ridge roof), has a white color, is of frame construction, and occupies .06 acres (later converted to approximately 2,600 square feet). House and barn types, with their respective characteristics, were quickly recognized in the preliminary reconnaissance. Thus, the type number itself gave a detailed description of the structure.

THE RANCH

Subdivision of the original California "rancho" accompanied agricultural intensification in the Oxnard Area. By 1847 the lowland had been parcelled into eight ranches, although six of them were not wholly within the area (Fig. 2). Sizes ranged from 5,000 (Rancho San Miguel) to 49,000 acres (Rancho Ex-Mission). Boundaries were laid according to the metes-and-bounds system. Commercial livestock raising furnished the income. Some wheat, barley, corn, beans, and a few fruits and vegetables were raised, but for subsistence only. They were confined to small plots set aside for the Indian laborers on the ranch and for the "ranchero" and his family. Like other portions of coastal southern California, subdivision in the Oxnard Area proceeded more slowly than in the northern part of the state. Ranches specialized in cattle and sheep as late as 1873. Droughts, better communication with the East, and an increase in settlers from that same area spurred the change to grain. Barley, corn, and lima beans were the major ranch crops until 1900.

Livestock raising remained important on ranches having both fertile lowland and rough hill and mountain land. Cattle and sheep were grazed on the grain stubble of the lowland in the fall and winter and native pastures of the highlands for the rest of the year. This system disappeared with the increase of winter cropping on the lowland, but livestock still roam the hill and mountain sections today.

Grain was gradually replaced by citrus, walnuts, lima beans, sugar beets, alfalfa, and vegetables as the major staples of the Oxnard Area ranch. But the change from cattle and grain to fruit and vegetables proceeded differently, depending upon the location. Many ranches situated north of the Santa Clara River and El Rio were already specializing in fruit and nuts by 1900, but a majority of ranches in Pleasant Valley (a partial enclave of the Oxnard lowland surrounded by the Camarillo Hills and the Santa Monica Mountains—Fig. 1) first began concentrating on tree crops around 1920. Ranches on the Oxnard Plain, the remaining—and largest—part of the Oxnard lowland, are just now starting to change from vegetables and grain to citrus. Several factors explain these local differentiations: construction of the first railroad north of the Santa Clara River which encouraged early formation

of ranches there by incoming settlers; earlier ranch dismemberment by large American landowners in the same area; more public land available in Pleasant Valley during the first stages of American occupation; a high water table and strong alkali concentrations which, until more recent artificial drainage operations, precluded any citrus and walnut tree plantings on the Oxnard Plain.

These local variations were already evident by 1890, if the few ranches described by early authors were true examples. One ranch of 630 acres specializing in stock raising and feed crops is described on the Oxnard Plain in 1890.[5] Another in the same area in 1878 contained 340 acres, 120 of which was in barley, 150 in corn, 40 in beans, and 30 in pasture and vegetables.[6] A completely different picture is given of a ranch near Saticoy. It was only 80 acres and contained "2,000 apricot trees, 1,500 apple trees, 500 lemon trees, 500 orange trees, and 1,000 walnut trees."[7] Such variations, although less striking, are still evident today. While 65 per cent of the ranches in the Oxnard Area in 1949 varied from 20 to 200 acres in size, most of those north of the Santa Clara River averaged less than 50, in Pleasant Valley, 50 to 100, and on the Oxnard Plain, 50 to 200.

TABLE I

Ranch Size by Area

Acres	Ranches by sample areas																		Total*	Per cent of total
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R		
1–20		3	1	1	2	2										2			11	15
20–50	4	3				1				1	1	1		1		1		1	14	19
50–100			3	2			1	2	1	1	1	1	2	2	1	1	1	1	20	28
100–200			2						1	3	1	3	3						13	18
200–300					2	1				1	1					1		1	7	10
300–400					1										1				2	3
400–500								1	2			1							4	6
500–																1			1	1

* Data for only 72 of the 105 sample ranchsteads could be obtained.

The more valuable oranges, lemons, and walnuts are the logical specialties of most of the smaller ranches. Over 66 per cent of those ranches in the orchard sections averaged less than 100 acres; sixty-two per cent of the ranches in the field crop areas averaged between 50 and 200 acres. The latter ranches now practice a "lima bean–sugar beet–alfalfa (or barley)" rotation system, but this is disappearaing as tree crops come in.

A ranch is defined in this paper as all the land that is directly worked by one person. If the ranch is defined on the basis of ownership, however, the trend to-

[5] Y. S. Storke, *A Memorial and Biographical History of the Counties of Santa Barbara, San Luis Obispo, and Ventura, California.* Chicago: The Lewis Publishing Company, 1891. p. 250.

[6] *Ventura Signal,* n. d., 1878.

[7] J. D. Mason, *History of Santa Barbara and Ventura Counties.* Oakland: Thompson and West, 1883. p. 401.

ward smaller ranches in the Oxnard Area appears somewhat less marked. Tenancy commenced with the first partitioning of the large ranches. Much of the land was put up for lease, as well as sale, in amounts of 40 to 160 acres. Although most contracts allowed tenants first right to buy at expiration of the lease, not all availed themselves of the chance. Steadily increasing land values since 1890 made it impossible for many to purchase property. Yet, the tenant system fostered an increasing rural population by allowing the rancher to become an operator despite such high land values. Tenancy also provided a flexible organization better adapted to the raising of highly speculative crops. An organization with a larger financial reserve could more easily withstand the shock of a sizable price drop than the small owner-operator.

Tenancy, however, has been steadily declining almost from its beginning. The rise of cooperatives reduced financial risk, thus lessening the financial practicality of the tenant system. The practice of investment companies planting citrus on their properties and then subdividing for sale has greatly contributed to the increase of independent ranchers. High values of three crops in the Oxnard Area have also enabled the ranches who cannot afford to buy a very large piece of land to make a comfortable living on a fairly small area. Tenancy in orchard areas is also discouraged by rents which are higher than those in field crop districts. Greater investments in the groves is the major cause for this difference. Owner-operated ranches now predominate in all three crop areas (cf. Tables II and III). Currently-expanding lemon acreage in the old field crop sections presages a continued increase of owner-operators.

Although steady, the decrease in tenancy has not been spectacular. Almost half of the Oxnard Area ranches were still tenant-operated in 1949. The tenant system has enabled several prosperous ranchers to rent other ranches, thereby reducing the trend from large to small ranches in some local areas. Rapidly expanding urban immigration, especially since World War II, is stimulating the demand for homes—and boosting the price of land. Many large ranchers thus have refused to subdivide and sell their land to small operators as long as there remains an opportunity of eventually getting a better price. In the meantime, tenants on the property provide the large rancher with an income. A more minor obstacle to a rapid decline in tenancy is the desire of some of the old settlers to retain their land through their descendants as a matter of family pride and tradition.

Four major forms of tenancy now exist in the Oxnard Area: part-owner, manager, share-rent, and share-cash. Part-owners and managers comprise the majority of tenants. The former rent land from others besides that which they own. Managerial systems are steadily becoming more popular. Managers operate the ranches for other persons, or for large concerns whose headquarters in some cases are not even located in the Oxnard Area. Managerial tenancy is representative of most of the ranches owned by investment companies. Share-rent tenants specialize in field crops and contribute ¼ to ⅓ of the harvest as rent. Cash payments are more typical among tree crop ranchers. As mentioned previously, cash rents are high, an average

TABLE II
Ranch Size by Crops and Area

Acres	Tree crop-ranches by sample areas							Total	Per cent of total	Field crop-ranches by sample areas											Total	Per cent of total
	A	B	C	E	I	O	P			D	F	G	H	J	K	L	M	N	Q	R		
1–20		3	1	2			2	8	24	1	2										3	8
20–50	4	3					1	8	24		1			1	1	1		1		1	6	15
50–100			3		1	1	1	6	18	2		1	2	1	1	1	2	2	1	1	14	36
100–200			2		1			3	9					3	1	3	3				10	26
200–300				2			1	3	9		1			1	1					1	4	10
300–400				1		1		2	6													
400–500					2			2	6				1			1					2	5
500–							1	1	3													
								Total 33	46% of all ranches												Total 39	54% of all ranches

TABLE III

Ranch Tenure by Area

Type	Ranches by sample areas																		Total	Per cent of total
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R		
Owned	4	5	6	3	5	2	1	2	4	1	2	5	4	3	2	5	1	2	57	54
Rented	4	2	2	1	7	3	2	3		6	4	2	3	1	2		4	2	48	46
No data*	3	1	2	1	6	1		2			2	1	2	1	1		4	1	28	..

* The "No data" column refers to 28 ranchers from whom no information could be obtained. Since only 10 of the remaining 77 had an income which was primarily non-agricultural, it was assumed that such was the proportion for the 28. They were thus included in the "Rented" column.

minimum being 50 per cent of the gross returns of the crop. Share-rent and share-cash tenants supply the labor, while most of the machinery, seed, and other materials are provided by the owner. The annual lease is an accepted practice.

Inability of the owner operators to increase their numbers as rapidly as those of property subdivisions is reflected in Figure 2. The northern half of the old Calleguas ranch, for example, is still intact under one owner, although it has been well subdivided among tenants. But frequent shufflings of ownership have also produced a dispersed type of property which is suggestive of the open-field system common in the Far East and Europe. Both large and small properties exhibit this form. Several of the larger properties, of both contiguous and fragmented shapes, comprise several thousand acres each. A fourth type of ranch shape based on ownership is the small and contiguous property. Subdivision of the original Mexican ranches has also produced a curious combination of property lines derived from both the metes-and-bounds and range-and-township survey systems.

THE RANCHSTEAD

Ranchstead, as well as ranch, modifications reflect the tremendous changes in California agriculture. Modifications of both units are naturally closely related. Thus ranchsteads have also become generally smaller and more numerous. Ranchsteads in the Oxnard Area today also have about the same local areal differentiations in size as those of the ranches. Although the ranchsteads average 1.5 acres and less, sizes vary from .0–1.0 acres on the northern margins to 0.5–1.5 acres in the central part. Sizes are more diverse in Pleasant Valley to the east. A sizable proportion of the Oxnard Area's very large ranchsteads (over 3.5 acres) are also found here.

Ranchsteads have become more diverse and elaborate. The almost exclusive type of ranchstead in the cattle raising days of Mexican rule was large, although simple from the standpoint of function. It consisted of a large, often two-story, adobe house, and a half-dozen, or more, thatch-covered huts in which the Mexican cowboys (*vaqueros*) and their families resided. A harness shop and school were occasionally included. Nearby were the small gardens and orchards that supplied

TABLE IV
Ranchstead Size by Area

Acres	Ranchsteads by sample areas																		Total	Per cent of total
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R		
.0–0.5	3	2		1	5	2			1	1		1		1		2	1		20	19
0.5–1.0		3	2	1	2	2	1	1		2	2	2	4	1		1			24	23
1.0–1.5	3	1	1		2	1	2	2	1	2	1	2	2	2	1	1		2	26	25
1.5–2.0	2	1	1	1				1	2		1	2					1		12	11
2.0–2.5			1		2			1		2	2		1				1		10	9
2.5–3.0			1													1		1	3	3
3.0–3.5			1	1											1				3	3
3.5–			1		1										2		2	1	7	7

the ranchstead occupants with food. Challenging the residence of the owner for prominence was the large branding corral. This kind of ranchstead quickly disappeared with the decline of cattle raising and the influx of American settlers.

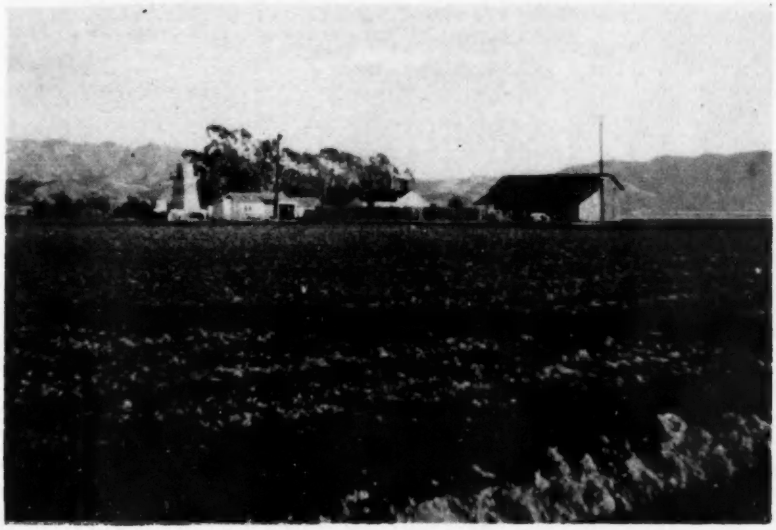

FIG. 3. A simple ranchstead with a "single wing" barn. From left to right: tank towers, tenant house and garage, workshop, main house, barn.

The "simple" ranchstead (Type 1; Fig. 3) has been one of the best indices of the progress of American rural settlement in the Oxnard Area. Almost as small as the "residence" ranchstead (Type 4) of the rural-non-farm resident but different in function, this "simple" type already outnumbered other types as early as the 1880's. Today it dominates the entire Oxnard Area and comprises 64 per cent of all ranchsteads in the area. The simple ranchstead usually has a size of less than 1.5 acres.

Structures of the simple ranchstead have only partly reflected increasing crop-type specialization. Barns are less common in the orchard areas where the now-obviated need for livestock, and hence their shelter, was not as pressing. An occasional walnut huller and dehydrator is found in the walnut areas. Except for storage of some hay, little of the harvested crops is kept on the ranchstead. The present primary functions of the simple ranchstead are the housing of the rancher and his family, the storage and maintenance of farm machinery—as well as storage of other necessary agricultural supplies, and the supplying of the occupants with a limited supply of vegetables and fruit from a home garden and orchard.

FIG. 4. A plantation ranchstead. From left to right: machine shed, workshop-machine sheds, tenant dormitory, garage, main house. Water tank on hill.

The "plantation" ranchstead (Type 2; Fig. 4) is similar to the "dairy" ranchstead (Type 3) in that its numerous, large buildings, and extensive area represent the highly commercialized phase of agricultural development in the Oxnard Area. The former type has had as long a period of development as the simple ranchstead. The earliest kind of plantation ranchstead specialized in stock-raising. An example is described thusly:

The ranch buildings were back from the main public road about three quarters of a mile. They consisted of several large barns, each one taking care of twenty-four horses, with hay in the center. There was a large granary, a blacksmith shop and machine shed, a harness shop and several bunkhouses. A large kitchen and dining room, and a couple of houses were provided for help that had families. Back of the bunkhouses . . . [was a] . . . vegetable garden. . . .[8]

[8] W. P. Daily, *An Album of Memories.* Santa Barbara: Schauer Printing Studio, 1946. p. 112.

By 1900, cattle raising had given way to crops. Although specialization is different (either wholly in tree or field crops), the plantation ranchstead remains large and elaborate. Sizes range from 1 to well over 3.5 acres. Functions provided are the same as those of the simple ranchstead, but on a much larger scale.

Plantation ranchsteads concentrate at present in the more favorable, tree crop areas of the northern and eastern parts of the lowland. This proportionate distribution is exactly contrary to that of ranch size. Such an anomaly is partially explained by the use here of the definition of a ranch as given above. If ownership were the sole criterion, this odd relationship of small ranches and large ranchsteads would be modified, since many of the operators are only tenants. This paradox is further minimized by the fact that plantation ranchsteads, even in their areas of greatest density, are vastly outnumbered by the simple type. Plantation ranchsteads in 1949 comprised only 16 per cent of all Oxnard Area ranchsteads.

TABLE V

Ranchstead Type by Area

R. type	Ranchsteads by sample areas																		Total	Per cent of total
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R		
1	6		5	4	4	4	3	5	2	7	5	6	6	4		1	3	2	67	64
2		3	3		3				2						4	1		2	18	16
3					1												1		2	3
4	2	4			4	1					1	1	1			3	1		18	17

Over three-fourths of the plantation ranchsteads are now run by tenant-operators (usually managers), in contrast to the simple ranchsteads where almost three-fourths are owner-operated. The amount of capital required to build and operate the former has obviously been the main reason for such a difference.

TABLE VI

Ranchstead Tenure by Ranchstead Type

Tenure	Ranchsteads by r. type			
	1	2	3	4
Owned	46	4		7
Rented	21	14	2	11

The rise of the "dairy" and "residence" ranchsteads evidences the rapidly increasing population of modern California (Figs. 5–6). Both ranchsteads have become important in the Oxnard Area since 1920. Although it comprised only 3 per cent of all ranchsteads sampled in 1949, the dairy type compensates in part by its large size and complexity. Only the plantation type equals its size (1.0–3.5+ acres). Numerous cattle corrals definitely characterize this ranchstead; dairying is easily the most important function.

FIG. 5. A dairy ranchstead. Corrals in foreground. Milking barns in middle background. Hay barn in extreme right background.

FIG. 6. A residence ranchstead. From left to right: machine shed, house, garage.

Residence ranchsteads are the smallest of the Oxnard Area ranchsteads (.0–0.5 acres) but also are the most rapidly growing type. As implied by title, the income of the resident is chiefly non-agricultural—although a small piece of land accompanies

the residence ranchstead and provides some additional revenue (e.g., a 10-acre lemon grove). Such "work" buildings as barns, workshops, etc., are consequently scarce. This type of ranchstead is usually the culmination of the desire of the city dweller to enjoy the benefits of rural life, while at the same time being not too far from his job and the conveniences of an urban area. Hence, most residence ranchsteads concentrate near the city of Ventura, or near Camarillo, where scenic, as well as economic, attractions are particularly great. Residence ranchsteads already comprise 17 per cent of all ranchsteads in the Oxnard Area. With the continuing increase of urbanization, so striking in California today, this proportion seems due for even greater increase.

A building-by-building examination of these four major ranchstead types reveals their evolution and differences even more clearly. Buildings for the present Oxnard Area ranchstead average from 3 to 7 in number. When the ranchsteads are broken down into types, however, these figures hold true only for the simple ranchstead. The plantation ranchstead averages 7 to 14. The dairy ranchstead is difficult to classify but the tendency is more toward over, rather than less, 6. Two to 3 buildings is most common for the residence ranchstead.

TABLE VII

Number of Ranchstead Buildings by Ranchstead Type

R. type	Ranchsteads by number of buildings														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14+
1			7	10	13	14	17	2	2	2					
2						1	3	1	3	3		1	2	3	1
3						1							1		
4	2	8	6	2											
Total	2	8	13	12	13	16	20	3	5	5	0	1	3	3	1
% of total	2	8	12	11	12	15	19	3	5	5	0	1	3	3	1

The number of buildings determines ranchstead shape in many cases. Where buildings are numerous, as in the dairy and plantation ranchsteads, shapes tend toward irregularity; the simple and residence ranchsteads, with fewer structures, have more square and rectangular shapes.

TABLE VIII

Ranchstead Shape by Ranchstead Type

Shape	Ranchsteads by r. type				Total	Per cent of total
	1	2	3	4		
Square, or nearly square	19	8		8	35	33
Rectangular, or nearly rectangular	31	4		8	43	41
Irregular	17	6	2	2	27	26

Of the ranchstead buildings, houses have changed the most during the agricultural development of the Oxnard Area. Five major house types had replaced the rambling Spanish adobe by the mid-1900's. Most common is the 2- to 4-room house with a rectangular ground plan (Type 1; Fig. 6). One-third of the houses are divided evenly between a 7- to 13-room structure with a square ground plan (Type 2) and a 5- to 8-room, single-story version (Type 3; Fig. 3). Eight per cent of the houses have four rooms and a square ground plan (Type 4). An equal percentage were L-shaped modifications of the Type 1 house (Type 5).

TABLE IX

House Type by Area

H. type	Houses by sample areas																		Total	Per cent of total
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R		
1	2	1		1	4	3	1	1		3		3	2		2	2	3		28	27
2	3	3	3		1			1	3				1	2	1				18	17
3		1	4	1				2		1	4	1	1					2	17	16
4		1		1	1		1					1	1	2				1	9	8
5					1	2	1	1		1						1	1		8	8
Misc.	3	1	1	1	5				1	2	2	2	2		1	2	1	1	25	24

Simplicity and neatness have characterized most of the houses built by the American rancher: 50 per cent of all the houses have square ground plans, 29 per cent are rectangular and only 9 per cent L-shaped; 59 per cent have 2 to 5 rooms; 76 per cent are single-storied. Surprisingly, house size increases very little with larger ranches. On the other hand, a much greater variety of house types is found on them (Miscellaneous). Only 3 per cent of all the houses are unpainted. The most popular colors are white (59 per cent) and cream (9 per cent).

Houses also give the best evidence as to the original eastern states background of the earlier settlers. Several houses still have steeply-pitched roofs. Eighty-five per cent have board siding. Sixty-three per cent are roofed with shingles.

In contrast to the main house, the tenant house[9] reflects agricultural intensification, rather than the origin of the rancher, in the Oxnard Area. With the increase of such crops as sugar beets, lima beans, and citrus, labor demands, such as weeding, harvesting, cultivating, and irrigating, became critical. Importation of large numbers of transient rural laborers was the only answer. Mexicans, or Americans of Mexican descent, have been most numerous since 1900. The most common type of tenant house is a simple 1- to 2-room structure of frame construction. Since most are occupied for only two to three months during the year, they are often allowed to fall into disrepair, detracting from the general appearance of the ranchstead. Thirty-six per cent of the simple ranchsteads have at least one such house. This is by no means indicative of the great number of tenant laborers used on the simple ranchsteads. Several hundred live in nearby towns and commute to the fields.

[9] Although the main house on the ranchstead houses a tenant in the majority of cases, it is only the tenant house which shelters the rural laborer—who works no specific piece of land.

A greater proportion of dairy, and especially plantation, ranchsteads have tenant houses. There are also many more per ranchstead than is the case with the simple type. Houses are larger and in better condition as well, some being of single-story dormitory style (Fig. 4). The increased and more enduring labor demands of the larger ranchsteads explain this contrast.

Not all tenant houses are situated on ranchsteads. Some are found in clusters, one being so large as to suggest a hamlet, although its only function is residential. As would be expected, few residence ranchsteads have tenant houses.

TABLE X

Ranchsteads with Tenant Houses by Area

R. type	Ranchsteads by sample areas																		Total	Per cent of r. type
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R		
1	3		3	3		2	1	2	1	2	1	2	2	2					24	36
2		3	3		4				1						2	2		2	17	94
3					1														1	50
4													1						1	6
																		Total	43	41% of all ranchsteads

Barns are rapidly becoming relict features of the rural landscape. Originally, they housed the stock, grain, and necessary feed. With the supplanting of horses by machinery and grain by more intensive crops, however, those functions ceased, and now barns are used for shelter of machinery and cars. Many, in fact, have been removed. Today only 62 per cent of the ranchsteads have them. The decline of the barn is also revealed in the fact that 37 per cent of the structures today are unpainted. Many of these were originally painted. Thirty-one per cent are painted red and 15 per cent are white. Barns are still important on the dairy ranchstead where they are used to shelter livestock and store feed.

Three major barn types can be recognized on the basis of form: Type 1, which has a single ridge roof and two adjoining wings; Type 2, which has the same roof style but no wings; and Type 3, which is similar to Type 1, except that it lacks one wing (Fig. 3). Types 1 and 2 are the cost common, about two-thirds of the barns being of type 1 and approximately one-third of Type 2. The barn wings were used for livestock while the grain and hay were stored in the larger central part. As in the case with houses, no one barn type is associated with any definite type of ranchstead. One small exception is the hay barn found on the dairy ranchstead. It forms a rectangular round plan and has a single ridge roof supported above the ground by a few timbers. The barn is open on the sides. Hay, commonly alfalfa, is stored here (Fig. 5). Unlike the other ranchsteads, the dairy type has several barns, the largest of which is used for milking, a smaller one for heifers, and the smallest which is the hay barn.

TABLE XI

Barn Type by Ranchstead Type

R. type	Barns by type			Total	Per cent of r. type
	1	2	3		
1	33	15	3	51	76
2	6	4	1	11	61
3	1	1		2	100
4			1	1	6
Total	40	20	5	65	62% of all ranchsteads
% of total	62	31	7	100	

Small barns have always predominated in the Oxnard Area. A mild climate, immediate shipment of much of the harvested grain during the 1870–1900 grain period, increasing emphasis on more perishable crops since that time, the decline of livestock since 1910—all help to explain this feature. Seventy-two per cent of the barns today cover no more than 2,000 square feet apiece. Barns over that size are found chiefly in the central portion of the Oxnard lowland. This is another evidence of the tardiness of this local section in converting from grain to more intensive crops, the reasons for which have been mentioned earlier. The larger barns are relatively most numerous on the dairy and plantation ranchsteads.

TABLE XII*

Barn Size by Area

Square feet	Barns by sample areas																		Total	Per cent of total
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R		
0–1000	1	1		1		2	1	1	2	1					1		1		12	18
1000–2000	4	2	4		2	2	1	2		1	5	3	4	1	1		2	1	35	54
2000–3000				2				2	1	1		2		1			1	2	12	18
3000–4000					1				1							1		1	4	6
4000–5000										1									1	2
5000–					1														1	2

* Tables XII and XIII refer to the three major barn types only.

TABLE XIII

Barn Size by Ranchstead Type

Square feet	Ranchsteads by type			
	1	2	3	4
0–1000	9	2		1
1000–2000	32	3		
2000–3000	9	2	1	
3000–4000		3	1	
4000–5000	1			
5000–		1		

High labor demands accompanying the increase in intensive agriculture, as well as the increasingly higher profits being derived from the growing of more valuable crops, is evidenced by a high degree of mechanization on the ranchsteads. Seventy per cent of them today have machine sheds while almost half have workshops. Seven per cent had more than one machine shed. As stated earlier, this building is usually synonymous with the barn. The machine shed combines its function with others in many cases, 12 per cent of them being combined with the workshop, 11 per cent with the garage, and 6 per cent with both the garage and the workshop.

TABLE XIV

Ranchsteads with Machine Shed by Area

R. type	Ranchsteads by sample areas																		Total	Per cent of r. type
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R		
1	1		5	3	3	4	3	5	3	7	5	5	6	2		1		2	55	82
2		1	2		3				1						3			2	12	67
3		1			1														2	100
4					1											2	1		4	22
																		Total	73	70% of all ranchsteads

TABLE XV

Ranchsteads with Workshop by Area

R. type	Ranchsteads by sample areas																		Total	Per cent of r. type
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R		
1	2		1	2	1	4		3	2	2	3	3	4	3			2	1	33	49
2		3	3		1				2						2			2	13	72
3																			0	0
4	1	2														1	1		5	28
																		Total	51	49% of all ranchsteads

Increased agricultural prosperity is also shown in the fact that 87 per cent of all ranchsteads investigated in 1949 had garages. Twenty per cent had more than one. One-fifth of the ranchsteads having garages utilized the barn. This index of prosperity would be somewhat higher if cars alone were recorded. The subtropical climate does not make car shelter a necessity.

That the rancher in the Oxnard Area has "grown up with the automobile" in the last thirty years is also illustrated by the ranchstead distribution pattern which pracically outlines the road network. Sixty-nine per cent of the ranchsteads front directly on the road. Construction of numerous roads has been no problem on the

TABLE XVI

Ranchsteads with Garage by Area

R. type	Ranchsteads by sample areas																		Total	Per cent of r. type
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R		
1	6		3	4	5	4	3	6	1	4	5	6	5	4		1	1	2	60	82
2		2	3		3				3						4	1		2	18	100
3					1														1	50
4	2	3			1	1					1	1	1			2			12	67
																		Total	91	87% of all ranchsteads

almost-level terrain of the lowland. "Off road" sites are more common for the larger ranchsteads than the smaller ones, as evidenced by the predominance of such a situation in the central part of the area (cf. Tables IV and XVII).

TABLE XVII

Ranchstead Location with Regard to Public Roads by Area

Location	Ranchsteads by sample areas																		Total	Per cent of total
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R		
On road	7	5	6		11	3	2	1	1	3	5	4	7	1	4	4	4	4	72	69
Off road	1	2	2	4	1	2	1	4	3	4	1	3		3		1	1		33	31

Another relict building on the ranchstead in terms of original function is the tank tower. At one time, it was a significant building, for it contained the domestic water supply. Today, two-thirds of the ranchsteads use the more modern and convenient gasoline motor-driven pump. Some tank towers have been retained even after the installation of the water pump, for the former provide an emergency domestic water reserve. A windmill on top of, or near, the tank house was once also a familiar sight. It, too, has declined in importance so that only 8 per cent of the ranchsteads now have them. Many tank towers have another current utility in that they provide housing for transient laborers or furnish convenient storage space. The supporting frame has been boarded up and the space enclosed has been partitioned into a lower and upper room. Tank towers have always been less numerous on the northern and eastern margins of the lowland where steeper fan and hill slopes provide gravity flow.

Historical changes in the non-building features of the Oxnard Area ranchstead also illustrate the development of the farming economy. Cattle and hog yards and fences, typifying a more extensive grain-livestock economy, were common features of the ranchstead as late as 1900. Only the extensive cattle "corrals" of the commercial dairy ranchsteads remain today, while the hog yard is found only in the large pens of a large hog-raising ranch in the area. Horse corrals have also declined

TABLE XVIII

Ranchsteads with Tank Tower by Area

R. type	Ranchsteads by sample areas																		Total	Per cent of r. type
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R		
1			2	1	1	2	2	2	1	2	3	4	1	3		1			25	37
2	1				1				2							1			5	28
3																			0	0
4		1			2	1							1						5	28
																		Total	35	33% of all ranchsteads

with the rise of the tractor. Such yards are currently located on only a few of the large plantation ranchsteads where horses are raised commercially or merely kept for pleasure riding. Home gardens and orchards, however, have always been prominent features of the ranchstead. They are well distributed and are prominent on all present ranchstead types. Sixty per cent of the ranchsteads had home gardens in 1949, while 49 per cent had orchards.

TABLE XIX

Ranchsteads with Home Garden by Area

R. type	Ranchsteads by sample areas																		Total	Per cent of r. type
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R		
1	5		4	4	2	4	1	4	2	2	1	4	5	1		1		2	42	63
2		3	3		1				2						1	1		2	13	72
3																			0	0
4	1	2			1	1						1	1				1		8	44
																		Total	63	60% of all ranchsteads

TABLE XX

Ranchsteads with Home Orchard by Area

R. type	Ranchsteads by sample areas																		Total	Per cent of r. type
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R		
1	4		5	1	1	3		1	1		2	4	4	1			1	2	30	44
2		2	3						2						1	1		2	11	61
3																			0	0
4	1	3			2	1						1				1	1		10	56
																		Total	51	49% of all ranchsteads

Chicken raising has always been a dependable supplementary food source for many ranchers. Thirty-eight per cent of the ranchsteads had chicken yards (only 2 per cent less than the figure for chicken houses) in 1949.

TABLE XXI
Ranchsteads with Chicken Yard by Area

R. type	Ranchsteads by sample areas																		Total	Per cent of r. type
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R		
1	1		3	2	2	1	1	1	1	3	3	2	5				1		26	38
2		2	2		2										4			1	11	61
3																			0	0
4	1				1							1							3	17
																		Total	40	38% of all ranchsteads

Windbreaks were introduced when the close-growing grain crops began to give way to row and tree crops. Sea breezes and plowed loam soils encouraged soil drifting and made erection of wind barriers imperative. Over 50 per cent of the ranchsteads now have windbreaks. Where the buildings are closely surrounded by groves—as in the northern and eastern parts, windbreaks have been unnecessary. If these ranchsteads are included, the percentage of ranchsteads having windbreaks is increased to 77.

TABLE XXII
Ranchsteads with Windbreak by Area

R. type	Ranchsteads by sample areas																		Total	Per cent of r. type
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R		
1	2			2	3	3	1	4		5	5	4	5	4			1	2	41	61
2			3						1						3			2	9	50
3																			0	0
4		3			1	1							1						6	33
																		Total	56	53% of all ranchsteads

The well-groomed appearance of most house yards has always been notable. Only 19 per cent of the ranchsteads surveyed in 1949 were without one. Most of the exceptions were several ranchsteads in the predominantly row and field crops areas, where the cultivated fields extend almost to the very edge of the house.

THE NORTHERN WET PRAIRIE OF THE UNITED STATES: NATURE, SOURCES OF INFORMATION, AND EXTENT

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WHEN I became interested in the occupation and utilization of formerly wet prairie in Iowa as a significant theme in historical geography, I was unable to find a general study describing naturally poorly drained land in the state and giving its location. In fact, an examination of geographical writing about the prairies showed that geographers have been only little aware of the existence of the former wet prairies. The first problem was, then, to "find" the *wet prairie* of Iowa. In the search, the scope of the study was widened to include a more extensive general area of wet prairie in which the chief wet lands of Iowa were included.

Some of the results of the inquiry into the degree of wetness and extent of the wet prairie at the time of settlement, together with an evaluation of types of source material, are presented in this paper. Briefly, the chief results of the search are, first, evidence that the *wet prairie* was at once type of natural vegetation, drainage condition, and natural land use classification; second, evidence that classification, description, and mapping of the soil constitute the most valid means of approximating the extent of the wet prairie which early pioneers encountered, with other types of information providing only secondary evidence; and third, a roughly comparable quantitative map showing the distribution of wet prairie at the time of white settlement in the north-central portion of the United States, with a more detailed map of Iowa.

THE NATURE OF THE WET PRAIRIE

The name "wet prairie" is unfamiliar to many geographers, but to the pioneers and many of their descendants it was in common usage, and it has received scientific sanction in reports of the United States Soil Survey and elsewhere. For example, *The Living Museum,* publication of the Illinois State Museum, included a brief essay on the wet prairie in its August, 1949, issue which contained the following description: "Once there were miles of wet prairie; it dominated much of central Illinois in particular and extended far north and south in the state. . . .It was especially the plants which were indicative of wet prairie—it was these, the tall marsh grasses, over which a man on foot could not see." Spartina, or slough grass, was said to be the signpost of the wet prairie. In addition to slough grass, tall panic grass, Canadian wild rye, reed bent grass, and—on its wetter, non-sod forming,

margin—big bluestem, are included in the *wet meadow* of the prairie ecologists.[1] Perhaps the pioneers included the still more hydrophytic sedges, rushes, and cat tails in the wet prairie. In general, the wet prairie was thought of as less wet than a swamp. In this study, however, the less extensive swamp is included with the more extensive wet prairie proper.

Observant pioneer farmers noted the closeness of correspondence of vegetation and the suitability of land for cultivation. For example, an ecologist reports, with apparent approval, that a farmer in Vermillion County, Illinois, in the east-central portion of that state, claimed that the land originally too wet to cultivate was covered mainly by slough grass, sedges, and rushes, and along the margins by big bluestem prairie.[2] The very name, *wet prairie,* was popular recognition of what was both vegetation and land type.

In some instances, conditions of poor drainage in the prairie have been described lucidly and precisely as to extent and location, usually, if for any considerable area, in terms of soil types. For example, in Warren County, Indiana, at the eastern edge of the Grand Prairie, the United States Soil Survey reported that at the time of first settlement, "much of the prairie was too wet for cultivation and a number of marshes which had not reached the state of 'wet prairie' were scattered throughout the area," and continued in reference to the Clyde silty clay loam, which occupied 18.8 per cent of the area of the county, "the early settlers found this type in a water-logged condition. It then comprised the sloughs or wet prairie."[3]

In Cerro Gordo County, in north central Iowa, a more recent soil survey made on a more detailed basis than that of Warren County, Indiana, generalized about the soils classed as poorly drained, together comprising over 40 per cent of the land area of the county, "When this section was occupied by farmers, all these soils were poorly drained and a large part of the land was covered by standing water during part of the year."[4] In addition, relevant statements about drainage conditions were made for most included soil types. The native vegetation of the Webster silty clay loam (11.1% of area) was reported as "a rank growth of bluestem on the better drained areas and slough grass in the more poorly drained areas;" the Webster silt loam (6.1% of area) had a bluestem sod, with slough grass in the wetter parts; for

[1] For the floristic composition of the wet prairie and its ecology such ecological studies as the following should be consulted: Ada Hayden, "A Botanical Survey in the Iowa Lake Region of Clay and Palo Alto Counties," *Iowa State College Journal of Science,* XVII, No. 3 (April, 1943): 277–416. Homer C. Sampson, "An Ecological Survey of the Prairie Vegetation of Illinois," State Department of Registration and Education, *Division of Natural History Survey Bull.,* XIII, Art. XVI, 1921: 523–577. B. Shimek, "The Prairies," *Bulletin of the Laboratory of Natural History,* State University of Iowa, 6, No. 2 (1911): 169–240. J. E. Weaver and T. J. Fitzpatrick, "The Prairie," *Ecological Monographs,* 4 (April, 1934): 109–295.

[2] Sampson, *op. cit.,* pp. 541 and 543. Presumably, a minor part of the big bluestem prairie was included in the wet prairie.

[3] E. J. Grimes and E. H. Stevens, "Soil Survey of Warren County, Indiana," U. S. Department of Agriculture, *Sixteenth Report, Field Operations of the Bureau of Soils,* 1914: 1610.

[4] J. A. Elsell, H. L. Dean, Foster Randolph, and E. W. Tigges, "Soil Survey Cerro Gordo County, Iowa," *Soil Surveys,* Series 1935, No. 13: 26.

the Webster loam (.3% of area), it was reported that not all required tiling for cultivation; for the areas of Floyd silt loam (4.9% of area), it was stated that much could then be farmed without tiling, whereas the Floyd silty clay loam (.6% of area) was formerly (before tiling) too wet to cultivate; for the Clyde silty clay loam (4.8% of area), a native vegetation of "rank growth of prairie and slough grasses" was described, and the soil was, over its greater part, too poorly drained to cultivate without tiling; the Clyde silt loam (1.6% of area), although better drained was even then 62 per cent in pasture and hay; the Benoit silt loam (4.2% of area), required some tiling in most places for cultivation and the Benoit silty clay loam (1.1% of area) had few areas that could then be cropped without tiling; and the Bremer silt loam (.4% of area) had a native vegetation varying from prairie grasses on the better drained parts to slough grass on the more poorly drained. The vegetation and drainage conditions of the other soils classed as poorly drained were not characterized so exactly; however, the small areas of peat and muck (2.4% and 1.3% of area) obviously were too wet for cultivation. Of the soils named above, totaling 38.2% of the area, none was consistently well enough drained not to require tiling in part, at least, although the part of the Webster silt loam having a native vegetation of bluestem sod (in distinction to big bluestem in wetter habitats), part of the Webster loam, part of the Floyd silt loam, a small part of the Benoit silt loam, and, perhaps, part of the Bremer silt loam could at the time of the soil survey be cultivated without drainage. It is probable that drainage conditions had been improved through the long period of farming and road building in the county.[5]

The identification of soil type, vegetation, and drainage condition as nearly coextensive is stated more explicitly in the case of Warren County, Indiana, and Cerro Gordo, Iowa,[6] than in most areas. Nevertheless, such is the connotation of the soil survey reports for much of the northern well-watered prairie. Reference may be made to the following soil surveys, among others, for pertinent description: Blue Earth County, Minnesota, 1906; Buena Vista County, Iowa, 1917; Palo Alto County, Iowa, 1918; Wright County, Iowa, 1919; Stevens County, Minnesota, 1919; Chickasaw County, Iowa, 1927.

In the more northerly areas of wet prairie, where settlement was later than to the south, the descriptions of natural vegetation and drainage conditions contained in the soil survey reports are in part the result of direct observation by the soil surveyors, whose descriptions must be considered authoritative. For example, in the

[5] Weaver and Fitzgerald, *op. cit.*, p. 126, confirm the more humid condition of the soil under native prairie than of newly plowed soils adjacent planted to corn and wheat. Sampson, *op. cit.*, p. 531, speaks of general reduction of swamp area and lowering of the water table because of artificial drainage.

[6] The testimony in respect to the Webster and Clyde soils is especially important due to the commonness of those soil series, the former in the areas of late Wisconsin glaciation in central and north-central Iowa and southern Minnesota (Mankato Lobe) and of Clyde soils to the east and southeast of the Mankato Lobe. (The Fargo, represented only slightly in Iowa, is the chief soil series of the Red River Valley wet prairie.)

Crookston, Minnesota, area, within the Red River Valley, the following statement of the soil surveyors relative to the nature of drainage of the Fargo clay loam, which was mapped as occupying 64.3 per cent of the entire area, was an eyewitness account: "As a whole the drainage of this type is very poor. The narrow strips of land bordering the larger streams and coulees are usually fairly well drained, but artificial drainage is necessary on the greater proportion of the level areas, in order to obtain profitable yields from the crops grown."[7] From the North Dakota Portion of the Red River Valley, the contemporary statement that the season was such as to yield "best" crops only about one year in five on the Fargo clay soil because of the imperfect condition of drainage[8] signifies that, even in the climatically sub-humid western margin of the region in which much poorly drained soil was found, much of the land was actually wet enough to be classed as wet prairie according to standards prevailing farther east.

Even for central Iowa, some of the earlier soil surveys contain eyewitness descriptions of poor drainage, such as this one for Story County:

> "Low knolls are separated by saucerlike depressions in which impounded water often stands the year around. In many cases these low-lying areas have been reclaimed by artificial drainage, but in the main rainwater which falls upon uplands has to escape by seepage or evaporation. Little ponds and marshes are found in almost innumerable places scattered all over the county."[9]

Figure 1, which is based on soil description of the 1936 survey, in its southwestern "one-half" conforms to the description just given. The extensive area of poor drainage shown was also described in the survey of 1903. The two types of drainage condition patterns are, respectively: 1) the mottled arrangement of the end moraine, and 2) the extensive type of the flat till or lacaustrine plain. Generally speaking, poor drainage in the areas of Wisconsin glaciation in Iowa is due chiefly to surface configuration—ponding or flatness; whereas southward, relatively impervious subsoil becomes increasingly the chief cause. Actual sloughs become less frequent with distance to the south from the area of Wisconsin glaciation.

Only in the Illinois portion of the northern wet prairie are descriptions of vegetation and drainage conditions which were encountered by the early settlers infrequent in the soil survey reports (largely by the Illinois rather than United States Soil Survey).

The conclusion can be stated that much of the prairie was actually wet at the time of pioneer settlement, to the point that its vegetation was notably different from that of other prairie areas and that large areas were too wet for cultivation by the pi-

[7] A. W. Mangum and F. C. Schroeder, "Soil Survey of the Crookston Area, Minnesota," U. S. Department of Agriculture, *Eighth Report, Field Operations of the Bureau of Soils*, 1906: 877.

[8] Thomas A. Caine, "Soil Survey of the Fargo Area, North Dakota," U. S. Department of Agriculture, *Fifth Report*, 1903: 987. The Fargo clay, the only poorly drained soil recognized, was mapped as occupying 15.4% of the area.

[9] Herbert W. Marean and Grove B. Jones, "Soil Survey of Story County, Iowa," *Field Operations of the Bureau of Soils*, 1903: 836.

CONDITION OF DRAINAGE IN LAFAYETTE TP., STORY CO., IOWA

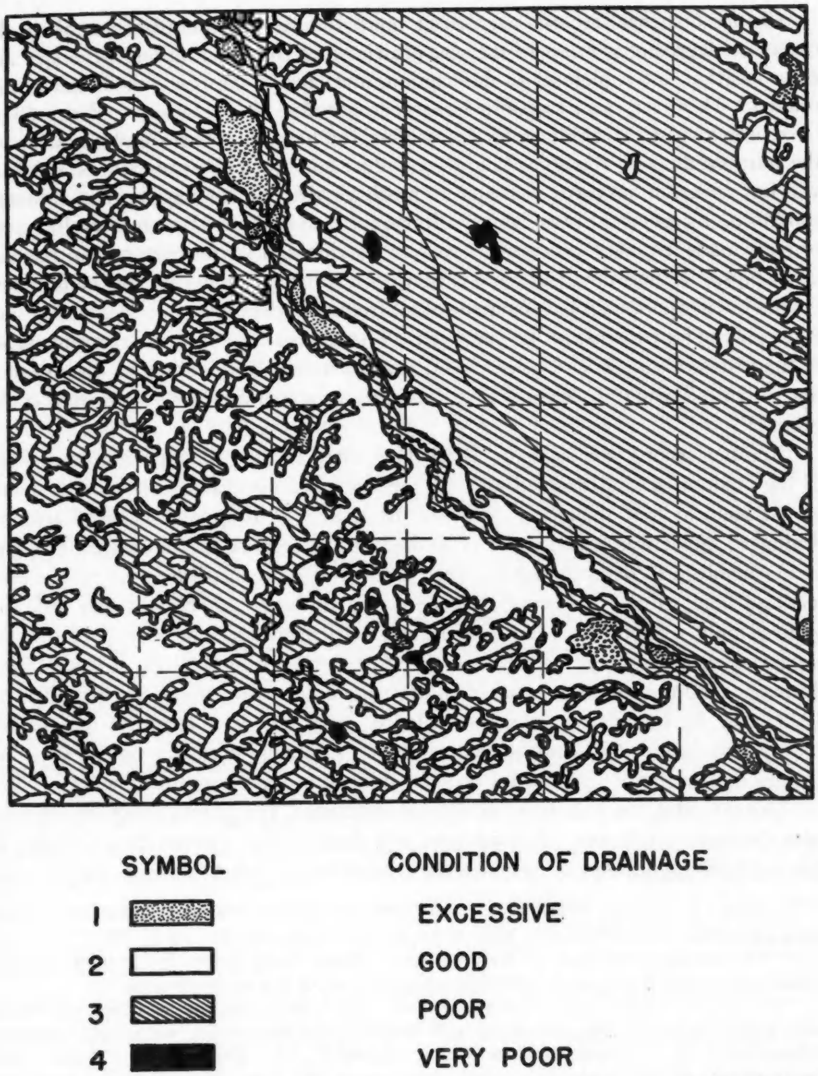

FIG. 1. The area mapped is the northwesternmost township of Story County, Iowa.

oneers. That the wet prairie was vegetation class, soil class, and natural land use type seems a tenable generalization for Mid-Western United States.

SOURCES OF INFORMATION

Chance historical records are of but limited value in generalizations about the extent or degree of wetness of the wet prairie since the observations were sporadic as to location, incomplete as to description, and largely impressionistic and uncorrelated. However, such records have corroborative value locally. What might have been a most valuable record, the original land survey, proves undependable for the purpose desired, the recording of or failure to record the presence of wet land varying with the surveyor perhaps as much as with actual variation in drainage condition. In a central Iowa county, Story, for example, the sixteen township maps or plats made from the surveyors' notes do not distinguish the wetter from less wet townships. Rather, the distinction is between surveyors. Only one of the four surveyors in charge of field parties made at all frequent reference to ponds, marshes, or lakes for the four townships he surveyed. The location of swamp land grants made to the states by the federal government can, for much of the area, be dismissed as not worth following up because of inconsistencies and fraud in the operation of the grants.[10]

Another record, the statistics from the United States drainage census of 1920 of the amount of land drained and the amount needing drainage by county units, would seem at first thought to provide the total area originally needing artificial drainage; but it was found to be of limited utility because of the subjective judgments involved in determining the need for drainage under different types of land use and land values. However, where public drainage enterprises had been organized only a short time and where close settlement had not long preceded the organization of drainage enterprises, the statistics by county units of the original drainage condition of land included in drainage enterprises, found in the census of 1930, may be considered valuable evidence, especially if a large portion of the county was included in drainage enterprises. Drainage statistics have value, but require interpretation. Statistics on land utilization have some pertinence.

Theoretically, the soil, like the natural vegetation, has close ecological relations with drainage conditions. Accordingly, soil characteristics other than drainage of the soil have high indicator value in the determining of past drainage conditions,[11]

[10] Roscoe L. Lokken, *Iowa Public Land Disposal.* The State Historical Society of Iowa, Iowa City, 1942. Pp. 180–209 deal with swamp land. Specific reference on p. 192.

[11] The following statement, kindly prepared by James Thorp, is intended to show the place of the poorly-drained soils of the prairie in a general system of soil classification:

"Dark-colored soils of the naturally well-drained prairie lands are classified as 'Prairie soils,' after Marbut (a); and the usually still darker-colored soils of the 'wet prairie' are called 'Wiesenboden' (b) or, more recently 'Humic glei soils' (c). Proportions of Prairie soils (well-drained) to Humic glei soils (wet) vary a great deal from place to place according to local relief, permeability of substrata, and natural outlets for subsoil water. Prairie and Humic

and the soil, unlike the vegetation, in the main has not been removed. Soil characteristics change so slowly that past drainage conditions can be reconstructed with a high measure of accuracy. Theoretically, the chief limitation of the method as applied to the problem of determining drainage conditions of the pioneer period is that the soils may have preserved the effects of even earlier conditions of poor drainage. Hence, the testimony of the soil as to the poorness of drainage should be cross-checked against other evidence.

The description of soils as seen by the soil surveyors or as reported to them by early pioneers indicates that the soils which had developed under conditions of poor drainage in most cases still suffered from inadequate drainage. Some evidence on this point has been presented. Only in portions of North and South Dakota was the opposite reported at all commonly, although the condition of drainage in Illinois at the time of settlement was not ordinarily reported in the soil surveys.

In addition to the theoretical difficulty just discussed, there are practical limitations, including incompleteness of areal coverage of soil surveys, variations in nomenclature and standards of classification and description from time to time, and from individual to individual. A few comments in regard to the importance of these limitations are in order: 1. Areal Coverage: The coverage by published soil surveys is nearly complete in Iowa and Illinois, but is less complete in Minnesota and least so in North and South Dakota. However, reconnaissance soil maps have been prepared by the Soil Conservation Service for most of North Dakota. These were utilized in mapping the wet prairie of North Dakota where soil surveys are lacking. 2. Differences in detail of survey: Generally speaking, the surveys made shortly after 1900 are much more coarse-grained in definition of soil series and types than later surveys and indicate less exactly former drainage conditions. Thus, in general, the older surveys indicate less accurately areas of poor drainage than the later surveys. In some counties a new survey indicates twice as large an area of poor drainage as an older survey of the same county. In Illinois, the older, coarse-grained system of classification found most extensive use. In that state, the counties surveyed on the newer, more exact basis, scattered among those surveyed earlier, have been made the basis for extrapolating drainage conditions over adjacent counties. 3. Differences due to different standards of individual soil surveyors: In many cases even the layman will appreciate that the description of the soil given in an early report does not fit the description given of soil of the same name in another locality. Thus, allowances can be made. However, despite efforts at standardization, the common use of non-quantitative standards relative to present and past drainage

glei soils have much in common. They are separated at about the point where artificial drainage becomes necessary for cultivation.

(a) C. F. Marbut, 1935, 'Soils of the United States' in *Atlas of American Agriculture*, Pt. 3, advance sheets No. 8, p. 14.

(b) Mark Baldwin, Chas. E. Kellogg, and J. Thorp, 1938, 'Soil Classification' in *Soils and Men, Yearbook of Agriculture*, p. 994.

(c) James Thorp, and Guy D. Smith, Feb., 1949, 'Higher Categories of Soil Classification: Order, Suborder, and Great Soil Groups,' *Soil Science*, LXVII, No. 2: 119."

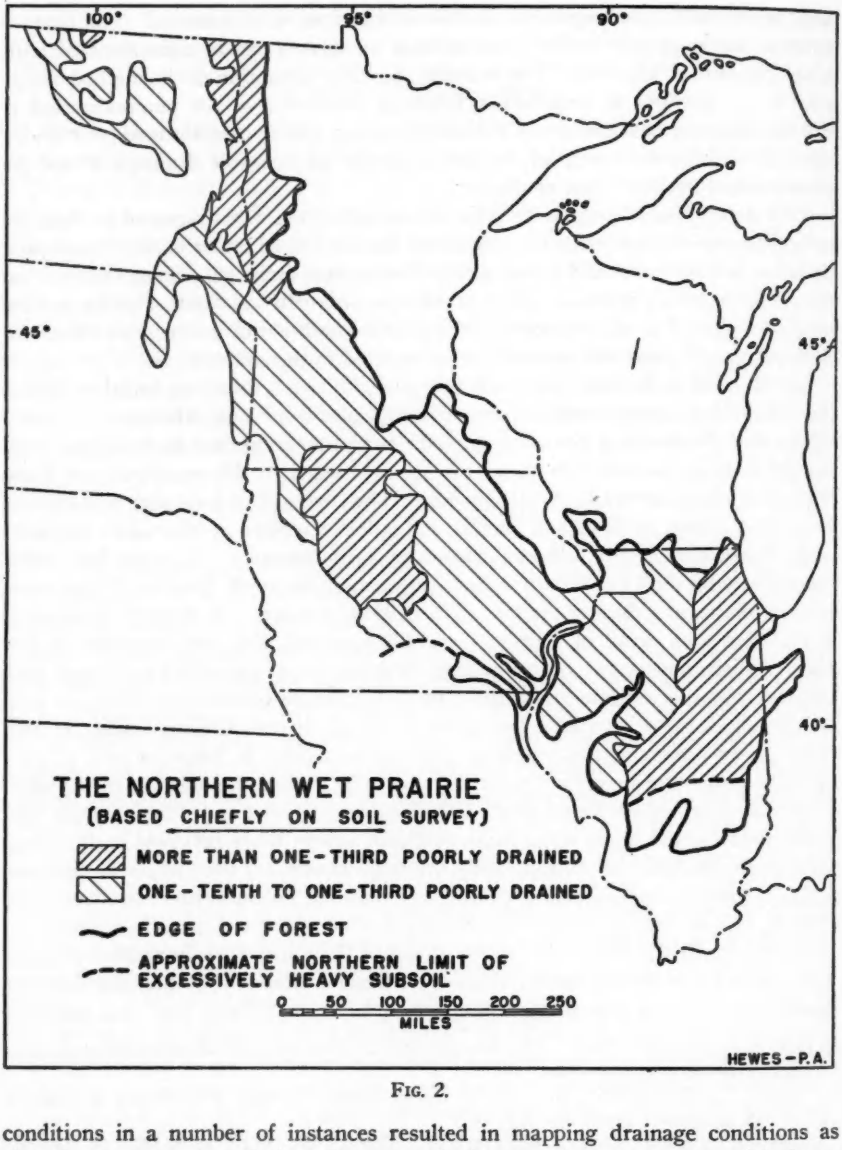

FIG. 2.

conditions in a number of instances resulted in mapping drainage conditions as changing at county boundaries. However, the fact that the gross pattern of drainage condition as mapped by this method is generally consistent is strong argument for the validity of the method despite the practical difficulties involved.

In general, the evidence in support of the indicator value of soil classification and description as given in the county soil surveys is so good as to warrant using soil survey classification and description as the chief basis of mapping natural drainage conditions in the northern prairies of the United States.

One of the best tests of the accuracy of the method, in the absence of comprehensive and areally detailed eyewitness accounts of the pioneer landscape, is that of comparing the geographical distribution of significantly related phenomena with the maps of wet prairie presented here. Such general comparisons will be attempted in the next section. In later studies, some detailed, close-up comparisons are planned.

The map of the wet prairie (Fig. 2) is based primarily on the soil survey. The major portions of the Iowa and Indiana prairies have been mapped by the United States Soil Survey and most of the Illinois prairie by the Illinois Soil Survey. As mentioned, the reconnaissance soil mapping by the Conservation Service has been used to supplement the meagre soil surveys of North Dakota. With neither good coverage by the soil survey nor any assurance that a major portion of the wet prairie in South Dakota is included in enterprises or has been drained, it is unlikely that the wet prairie is mapped even approximately accurately in that state. The map of the Iowa portion of the wet prairie is probably most accurate. With careful checking of other types of evidence, particularly of historical records, refinement should be possible for many areas throughout the region.

EXTENT OF THE WET PRAIRIE

The map of the Northern Wet Prairie (Fig. 2) shows three large centers of wet land: 1) the Grand Prairie of Illinois, with an extension into Indiana, 2) the Mankato Lobe of Late Wisconsin glaciation of north-central Iowa, with an extension into Minnesota, and 3) the Red River Valley.[12]

The prairie-woodland boundary shown on Figure 2 is based on the following sources: In Illinois, on soil classification and the vegetation map of Brendel and Barrows;[13] in Iowa, on the vegetation map by the Iowa State Planning Board based on the original land surveys;[14] in Wisconsin, on the adaptation of Lawrence Martin's map by Brown;[15] and in Minnesota on a map by the Minnesota Geological

[12] The principal areas of poorly drained soils in the northern prairies of the United States as mapped in plate 6 (Distribution of Soils Without Normal Profiles) of C. F. Marbut, "Soils of the United States," 1935, Part III of *Atlas of American Agriculture*, Washington, 1936, are in the same relative locations, but are smaller in extent, especially in Illinois. Presumably, the only areas shown are those in which soils without normal profiles due to poor drainage were judged to occupy over one-half of the land. However, wet prairie was prominent beyond.

[13] Reproduced in Sampson, *op. cit.*, p. 526.

[14] Reproduced in Leslie Hewes, "Some Features of Early Woodland and Prairie Settlement in a Central Iowa County," *Annals of the Association of American Geographers*, XL, No. 1 (March, 1950) : 41.

[15] Ralph H. Brown, *Historical Geography of the United States*. Harcourt, Brace, and Company, New York, 1948. P. 317.

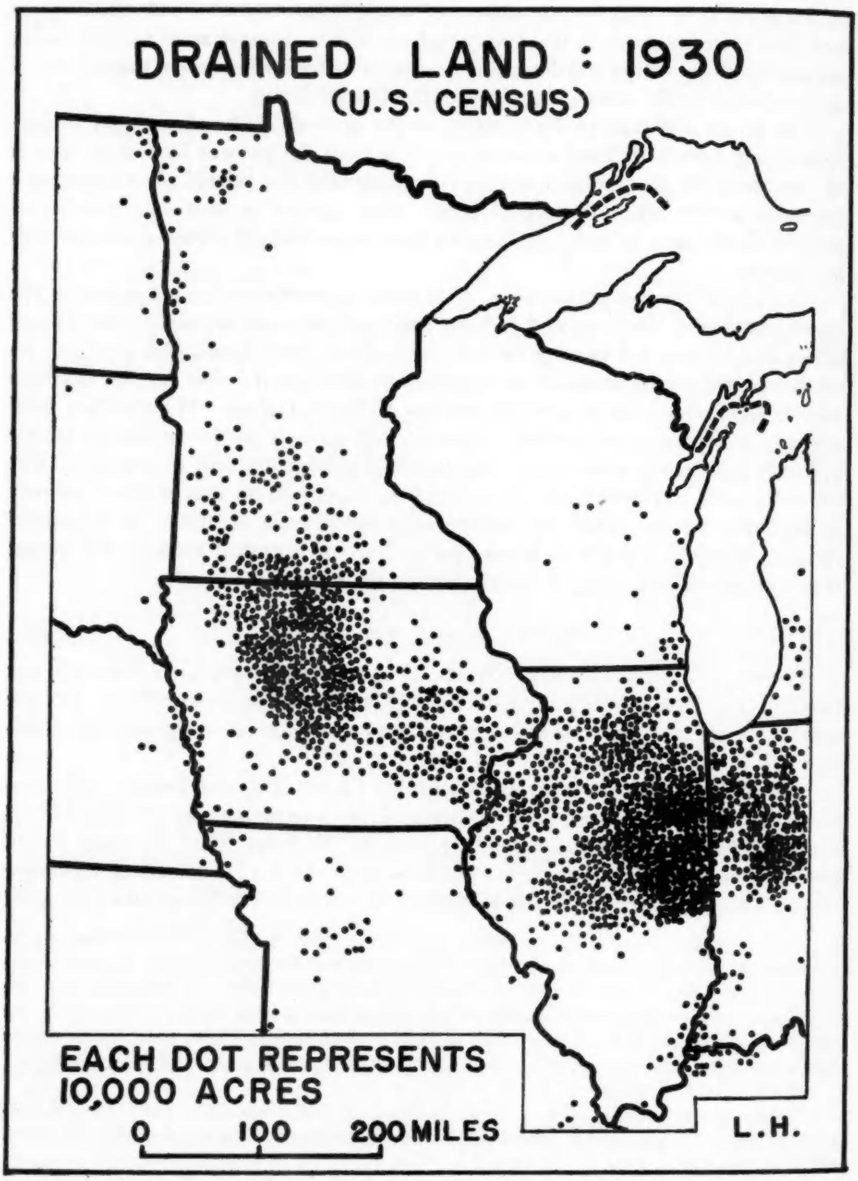
DRAINED LAND : 1930
(U.S. CENSUS)
EACH DOT REPRESENTS
10,000 ACRES
0 100 200 MILES
L.H.

FIG. 3.

Survey.[16] Many narrow river-side extensions of the forest into the prairie are ignored. On the south, the limit of the Northern Wet Prairie is set arbitrarily where the subsoil is nearly impervious, as shown by the limit of effective tiling. The boundary is especially sharp in Illinois.

A comparison of the map of the Northern Wet Prairie with one showing the distribution of artificially drained land (Fig. 3) should be of interest. The drainage data are for 1930, after which time statistics are available for organized enterprises only, thus not including the area, large in total, drained privately. The Grand Prairie and the Iowa portion of the Mankato Lobe are very prominent. A comparison of statistics shows far more land artificially drained than is classed as having poorly drained soils both in Illinois and in most of Iowa. In Minnesota and the Dakotas the reverse is commonly true. Probably, the chief explanation for these two types of discrepancy between soil data and drainage statistics is that economic considerations as well as wetness of land are involved. It may be assumed that artificial drainage has been more profitable and, therefore, is more common in poorly drained, even slowly drained, land in the Corn Belt than to the north of it. Later complete statistics, had they been available, however, would have shown considerably more artificial drainage than was mapped for 1930 in Minnesota and North and South Dakota. Figure 3, it may be concluded, over-represents the originally wet land on the south and southeast except for the "tight," hard-to-drain, lands of southern Illinois and southern Iowa and under-represents it to the north and northwest.

Figure 4, showing distribution of organized drainage enterprises, emphasizes the areas already identified as especially wet. However, in this case newly settled areas are represented more completely than areas long settled, where considerable drainage had been effected prior to the development of drainage enterprises. Thus, in Illinois and in southeastern Iowa originally wet land and actual artificial drainage are represented inadequately. However, where governmentally organized drainage enterprises are common the map of organized enterprises exaggerates the amount of land which was poorly drained because many of them include large amounts of well-drained land. Accordingly, in north-central Iowa and the Red River Valley, in which most drainage waited on the organization of enterprises, the wet prairie is over-represented. Figure 2 approximates an average of figures 3 and 4.

Drainage conditions in Iowa at or near the time of white settlement can be mapped with greater assurance than in other states formed within the well-watered northern prairies. This greater assurance is based on three considerations: 1) little use of broad-gauged classification, which was widely used in Illinois, 2) commonness with which drainage conditions at or near the time of settlement was reported, and 3) a much more complete areal coverage by the soil survey than in the other states except Illinois. Figure 5 shows three degrees of commonness of wet land in Iowa: 1) one-tenth to one-fourth, 2) one-fourth to one-half, and 3) over one-half of the area. The largest amount of wet land is shown within the Mankato Lobe

[16] *Ibid.*, p. 329.

of late Wisconsin glaciation; within the Mankato Lobe, the interior contains a larger proportion of wet land than the margins of the Lobe. The small inset map at the upper right-hand, which shows end-moraines in black, indicates the large degree to which higher percentages of wet land are found on the interior till plains. All counties located within the Mankato Lobe except Humboldt have been mapped

FIG. 4. Portion of map of drainage enterprises for 1940, by the Bureau of the Census.

by the Soil Survey. Humboldt County is bordered by counties of the wettest classification only. However, a geological report, which speaks of former swamps on the flat lands of the eastern and southern parts of the county and of "higher ground" to the north and west suggests that only a part of the county deserves the wettest classification.[17] The United States Geological Survey topographic map (Fort Dodge quadrangle, surveyed 1919–1921), which includes the southeastern part of

[17] T. H. MacBride, "Geology of Humboldt County," *Iowa Geological Survey Annual Report*, 1899, IX: 115 and 120.

the county, shows numerous marshes. Only a part of the county is given the wettest classification on Figure 5. The next most poorly drained portion of the state outside the Mankato Lobe is within the northern portion of the chief area of Iowan (early Wisconsin) glaciation.[18] The southeastern part of the Iowa prairie is shown as better drained than the areas just mentioned, although less so than the more rolling lands in the western part of the state. The chief uncertainty relative to the accuracy of the drainage condition map of Iowa, incidentally, arises from the border-line drainage conditions described commonly for east-central and south-

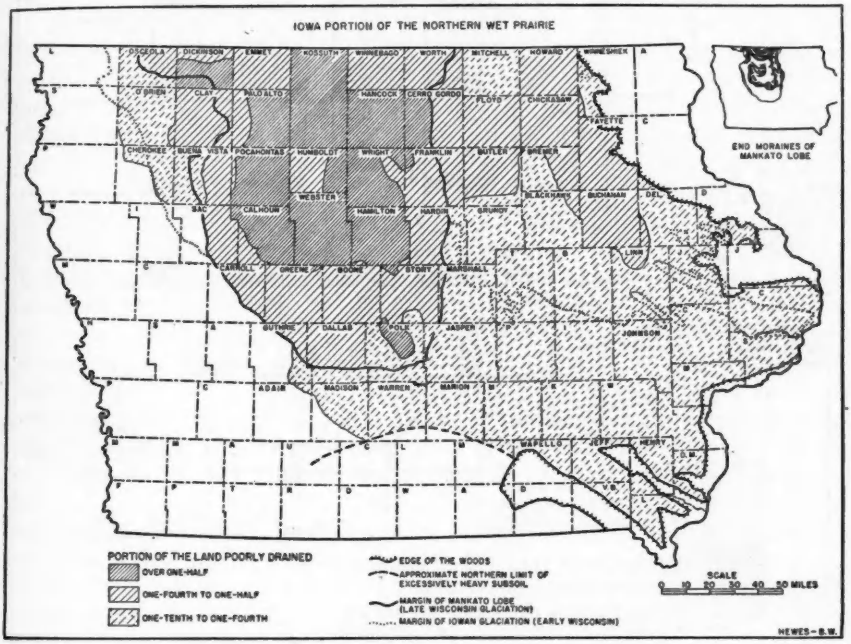

FIG. 5.

eastern Iowa; but the large amount of artificially drained land there, much of it drained early when only a major improvement in drainage condition would warrant the expenditures for drainage, suggests that the amount of wet prairie has not been exaggerated in Figure 5. The river bottom wet lands along the Missouri River

[18] Glacial boundaries and end moraines are taken from the *Glacial Map of North America by the Geological Society of North America*, 1945. The southern boundary of the wet prairie approximates the southern limit of effective tile drainage, which approximates the northern boundary of the Shelby-Grundy-Haig and Shelby-Seymour-Edina Soil Association Areas. Guy D. Smith and F. F. Riecken, in "Iowan Drift Border of Northwestern Iowa," *American Journal of Science*, CCXLV (Nov., 1947): 706–713, suggest the inclusion of considerably more territory in northwestern Iowa as covered by Iowan glaciation.

and some of its tributaries at the western margin of the state were ignored because of their narrowness. Although the extent of soil types by percentage of area was available only by county units, county boundaries were departed from where the soil survey maps warranted. The limited degree to which drainage condition boundaries

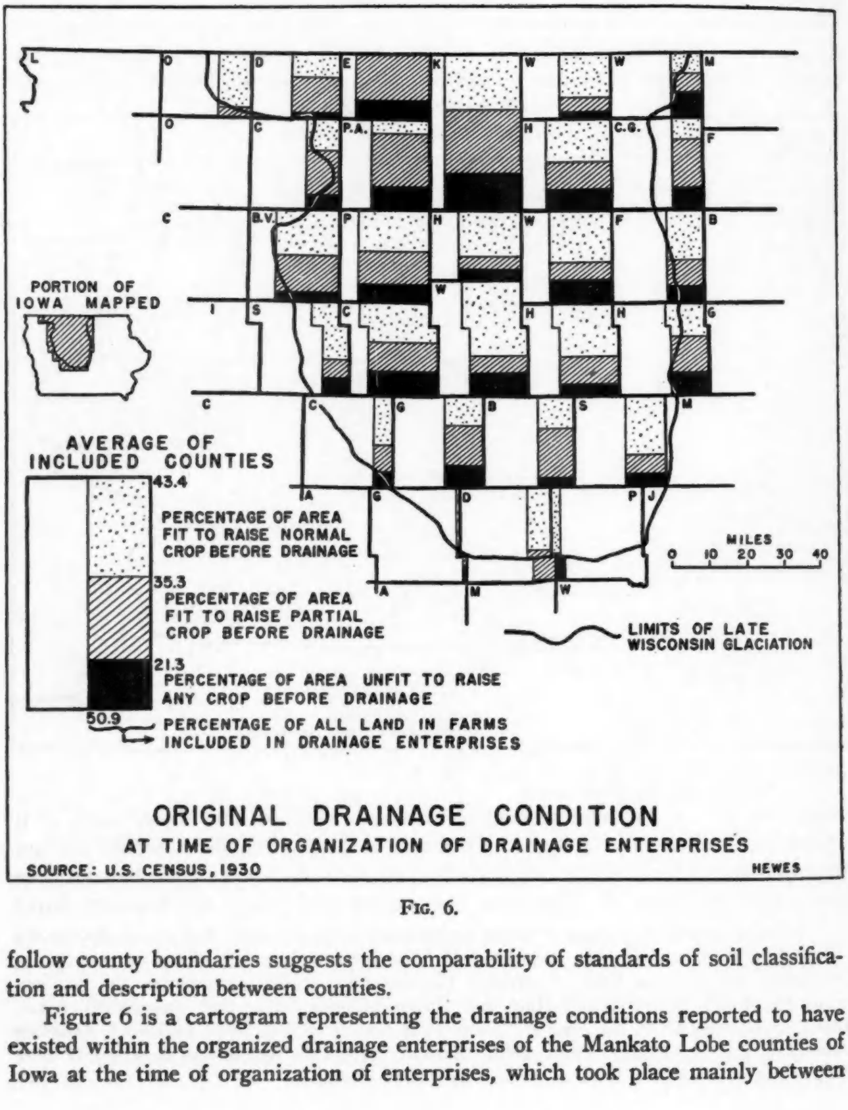

FIG. 6.

follow county boundaries suggests the comparability of standards of soil classification and description between counties.

Figure 6 is a cartogram representing the drainage conditions reported to have existed within the organized drainage enterprises of the Mankato Lobe counties of Iowa at the time of organization of enterprises, which took place mainly between

about 1910 and 1920. The shaded portions of the included counties represent the portion of the farm land which was included within the drainage enterprises. For all the enterprise areas included (amounting to one-half of the land) within the counties mapped, 21.3 per cent of the farm land was reported as unfit to raise any crop prior to drainage, an additional 35.3 per cent was shown as capable of raising only a partial crop, and only 43.4 per cent was classed as fit to raise a normal crop. If Mankato Lobe territory alone were included, the percentage of land in enterprises and percentages unfit to grow a crop or fit only to grow a partial crop would all be somewhat higher than the respective figures given.

A county-by-county comparison of "original" drainage conditions of the Mankato Lobe area of Iowa as based on soil description and soil mapping with drainage conditions reported as existing at the time of the organization of drainage enterprises is facilitated by a comparison of figures 5 and 6. The evidence as to original drainage condition of a county is the more meaningful for the inclusion of the major portion of the county within drainage enterprises, which is the case in the following counties: Kossuth, Emmet, Pocahontas, Calhoun, Hancock, Buena Vista, Wright, Hamilton, Humboldt, Webster, Dickinson, and Winnebago. Of the twelve counties, Kossuth, Pocahontas, Calhoun, Hancock, Humboldt, and Winnebago, appear to have had the same order of wetness according to the two lines of evidence, if both land unfit to raise any crop and land fit to raise only a partial crop before drainage be compared with the poorly drained soil areas. Not only a comparison of the map and cartogram, but also the statistical data from which the figures were prepared lead to this conclusion. Dickinson County can probably be added to this list on the reasonable assumption that the land in enterprises in the county averaged wetter than for the county as a whole. In two counties, Emmet and Buena Vista, it appears that the records of the drainage enterprises indicate considerably more extensive wet land than did the soil survey. Internal evidence suggests that the poorly drained soils in Buena Vista County were under-represented by the soil survey. There, the survey reported almost no stream valleys over the larger morainic part of the county, with little land beyond flood plains being drained by streams, in addition to stating that in the early days only a small part of most farms could be cultivated because of poor drainage.[19] A figure of approximately eighteen per cent for the poorly drained soils of the county is surprisingly low under the circumstances. In this case, the state geological report supports the description of drainage as very poor. In respect to the extensive portion of the county included in the Mankato Lobe, it was reported, "the entire central and eastern section of Buena Vista County is without any natural drainage at all. Instead we have here simply wide marshes and low sand hills," and "great marshes . . . affecting sometimes a township entire."[20] On the other hand, Wright, Hamilton, and Webster counties appear less wet on Figure 6 than on Figure 5. For Wright the discrepancy is not major. For

[19] Davis, Warner, and Rice, *op. cit.*, pp. 1595, 1597, and 1625.

[20] Thomas H. MacBride, "Geology of Cherokee and Buena Vista Counties," *Iowa Geological Survey Annual Report*, XII, 1901: 314 and 308.

both Webster and Hamilton the discrepancy is greater, but it is in order to note that by far the most extensive soil in Webster County was what was called Fargo loam, a type no longer mapped extensively in Iowa. The use of later, refined classification would probably have reduced the discrepancy greatly. Although most of the poorly drained soil of Hamilton County was Webster loam, the soil surveyors reported that it needed lateral tile lines as close together as four rods, indicating actual poor drainage.[21] Perhaps the long history of agricultural occupation and of tile

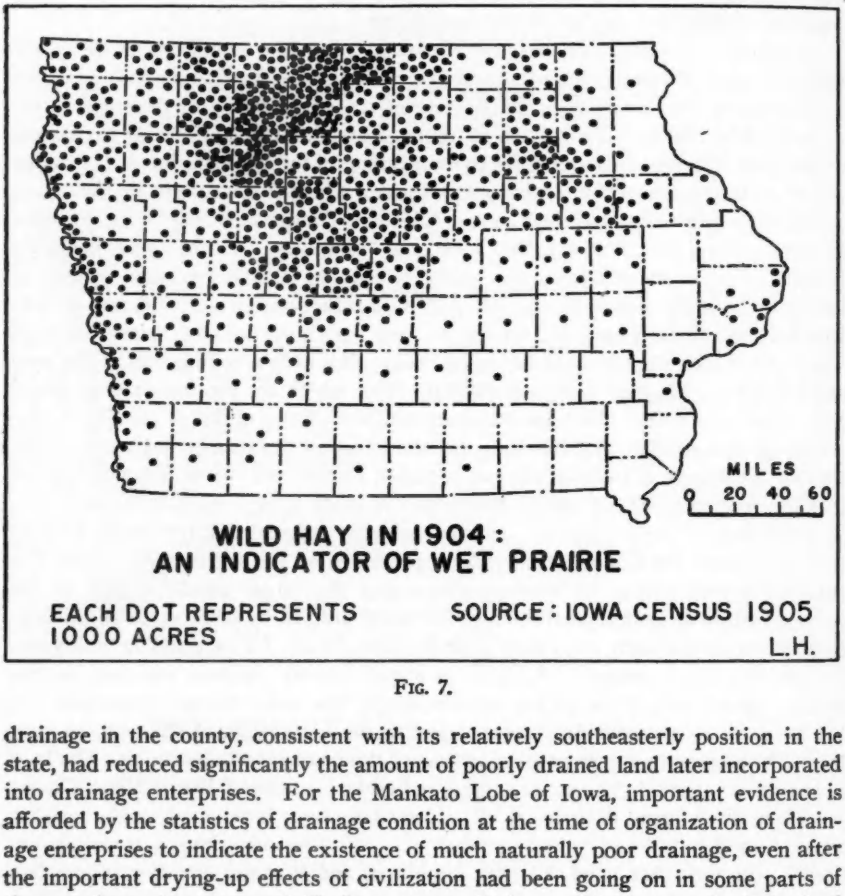

FIG. 7.

drainage in the county, consistent with its relatively southeasterly position in the state, had reduced significantly the amount of poorly drained land later incorporated into drainage enterprises. For the Mankato Lobe of Iowa, important evidence is afforded by the statistics of drainage condition at the time of organization of drainage enterprises to indicate the existence of much naturally poor drainage, even after the important drying-up effects of civilization had been going on in some parts of the area for as long as one-half of a century. It is possible that much of the land capable of growing a partial crop about 1910 would have been considered too wet

[21] Knute Espe and Lawrence E. Lindley, "Soil Survey of Hamilton County, Iowa," *Field Operations of the Bureau of Soils, Nineteenth Report,* 1917: 1645.

to cultivate a few decades earlier. With some exceptions, notably Buena Vista, and perhaps Emmet, Webster, and Hamilton counties, the evidence of "original" drainage condition reported by organized drainage enterprises supports the general correctness of the map based chiefly on the soil survey.

It seems in order to note that for the prairie portions of Minnesota, the county acreages in the "original area of swamp, wet, and overflowed lands" as reported in 1913 by the Minnesota State Drainage Commission,[22] are generally consistent with the areas reported in the United States Census of 1930 as unfit for cultivation at the organization of drainage enterprises, and in turn, the combined area of land unfit to raise any crop and that fit only to raise a partial crop at the organization of enterprises are generally consistent with the extent of wet prairie as based on soil classification and description in those counties surveyed by the United States Soil Survey.

Figure 7 is a map of wild hay acreage in Iowa in 1904. Ideally, the wild hay acreage should be an excellent indicator of poorly drained land after land use had become fairly intensive, but before artificial drainage had become common. The choice of the date, 1904, represents a compromise between these requirements. To the west, intensive land use had not yet required the nearly complete elimination of well-drained natural hay land, and to the southeast, a notable amount of artificial drainage had already been effected. The indicator value of the map is, therefore, compromised somewhat, exaggerating the amount of wet land to the west and minimizing it to the southeast. However, it emphasizes the Mankato Lobe as the wettest part of the state and indicates the considerable amount of poorly drained land within the areas of Iowan glaciation, chiefly to the east of the Mankato Lobe. The fact that the amount of drained land in the major area of Iowan glaciation, as shown on Figure 3, is less than is suggested by either the soils data represented in Figure 5 or by Figure 7 may be due to the fact that dairying activity in the area made profitable the use of wet pasture and hay lands in their undrained condition.

Figure 5, The Wet Prairie in Iowa, based primarily on soil classification and description, is the chief end product of the inquiry into the extent of the Iowa prairie which was too wet for ordinary crop farming at the time of settlement. The map is offered as a reconstruction of an aspect of the natural landscape important as a limiting factor in the development of the state.[23] Figure 2 serves as a less detailed, probably less accurate, approximation of the originally extensive wet prairie of the north-central part of the United States. The other maps, except for Figure 1, are cartographic representations of phenomena related to the wet prairie, useful in cross-checking on the accuracy of the maps of the wet prairie as based primarily on the classification, description, and mapping of the soil.

[22] Ben Palmer, "Swampland Drainage with Special Reference to Minnesota," *The University of Minnesota Studies in the Social Sciences,* No. 5 (March, 1915) : 122.

[23] Other studies are planned dealing with the role of artificial drainage. The first of these (with Phillip E. Frandson) is concerned with Story County, Iowa.

THE USE OF AIR PHOTOS FOR LANDFORM MAPS

ERWIN RAISZ
Harvard University

THE use of airplane photographs in the construction of landform maps[1] developed naturally. Landform maps show the land as it would appear if seen obliquely from a high-flying plane although in a symbolized fashion. Such maps were drawn long before flying was invented, but their popularity grew parallel with that of flying. It is possible to make a good landform map without flying if there are good topographic sheets and the maker is able to visualize them, but photos save time and effort and often are the sole source of information.

During recent years the author was called upon to make landform maps of various parts of the world, such as Alaska, Canada, Arabia, Turkey and Iraq, and North Africa, on scales ranging from 1 : 2,500,000 to 1 : 5,500,000. For none of the regions were there enough topographic sheets to be of much use, and most geologic maps showed the age of the formations rather than the kinds of rock which shape the surface. There was a chance to fly over some of the lands, but only a small fraction could be covered by a single person; nor was the weather always good. Most of the information came from the side pictures of trimetrogon photographs.[2]

Only photographic negatives were available in the case of Alaska. The reversal of light and dark is not bothersome in hilly or mountainous regions, but the strange markings of the plains are hard to visualize even in the positive, and are much more so in the negative. The information received was sketched upon the 1 : 500,000 aeronautical charts, and with the help of the available topographic sheets and geologic maps a 1 : 2,500,000 landform map was made.

In some ways this method was better than actual air travel, for the pictures were always taken in good weather, which does not come often in Alaska. Furthermore, the pictures taken in a full day of flying could be looked over in an hour or two. The roll could be stopped at any time to study the more complex regions while for uniform areas they could be scanned faster. On the other hand, the lack of colors made the interpretation more difficult than actual observation would have made it.

[1] Landform maps—or, as Lobeck calls them, "physiographic diagrams"—show the land in a semipictorial fashion with hill and mountain symbols which derive from the view of these features as seen from obliquely above, although applied to a vertically-seen layout of the map. This can be done only on very small-scale maps. The reason for doing it is to make the map readable to the average man. A landform map is not a bird's-eye view but rather the systematic application of type symbols. See E. Raisz: *General Cartography*, 2nd edition. (McGraw-Hill, 1948), pp. 119–122.

[2] The "tri-met" camera consists of three wide-angle cameras mounted together, one taking a picture vertically down while the other two take obliques left and right, so that the three pictures record sideways from horizon to horizon. The side pictures point 30° from horizontal.

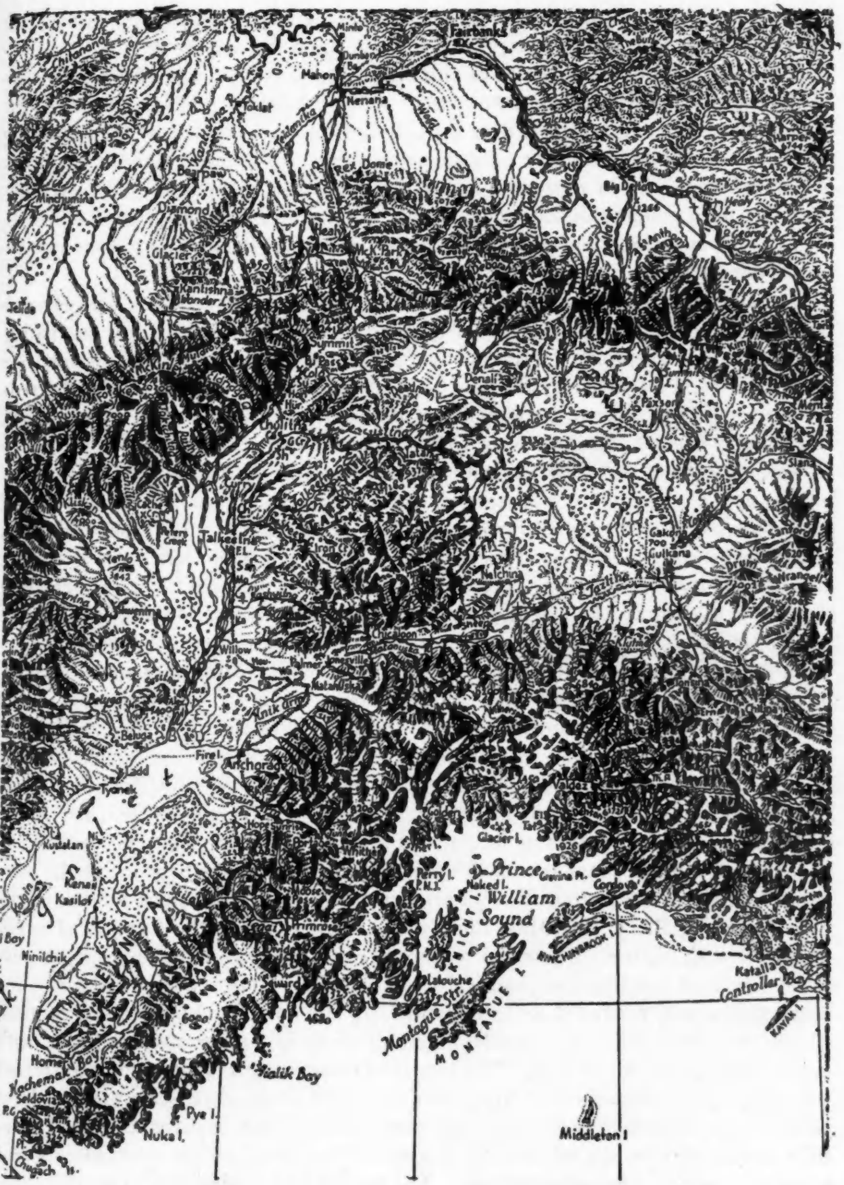

Fig. 1. Part of landform map of Alaska.

Forest types, dry tundra, wet tundra, barrens, etc., however, showed up clearly, and it is hoped they soon can be overprinted in color upon the map (Fig. 1).

With the map of Canada the conditions were more fortunate because the Air Photo Library in Ottawa has thousands of positive prints available. It was a distinct thrill to fly in an armchair over the lacework of lakes created by the collapsing permafrost of the Hudson Bay Lowlands and to see such features as the hundreds of parallel sand bars in western Ungava, the castellated cliffs of North Devon Island, the fiord country of Ellesmere Land, and the grooved plains of the North. It gave no less satisfaction to draw all this scattered information on a map and see it fall into a pattern.

In addition to some actual flying, most of Arabia was studied at the Trimetrogon Section of the U.S.G.S., using positives. Deserts seen from the air are fascinating and hold many surprises. Particularly unexpected is the prevalence of intricate river patterns accentuated by the whiteness of sand-floored wadies amidst the red-black rock. Deserts keep the patterns of the past much longer than humid lands, and we may assume that they were richly watered in the geological yesterday.

In a desert not veiled by vegetation, every geologic formation is clearly recognizable on a photograph by a specific texture. Since Arabia is ribbed by a series of successive sedimentary layers ranging from the Cambrian to Quaternary, there is ample opportunity to study and record patterns. The Arabian landscape is further complicated by block-faulting, vulcanism, and windblown sand. Thus we have the "hamads" (rocky plains with sinks) like the mottled stony Hajara, looking like a gigantic metal surface etched out by acid or in other places like the grain of a worn-down pine board, or like the chert-covered Dibdiba plains over some Tertiary limestone with sinks aligned along an older river system. The crystalline areas show a sand-choked joint or dyke pattern, and many "inselbergs." The rusty black lava has a pattern of its own, depending on age. Then there is the endless variety of sand dunes, some with wide, flat, long, parallel waves, some knifelike, some scale-like or wavy. Our language is inadequate to describe all these features; the Arabs do better, having a dozen terms for various sand dunes alone (Fig. 2).

With all of these maps the usual method of procedure was to work at the Air-photo Library of the Aeronautical Chart Service or the Trimetrogon section of the U.S.G.S. using the 1 : 1,000,000 flight-index maps showing the location of every third or fourth picture. These index maps are available in ozalid copies if permission is obtained from the Aeronautical Chart Service. Permission is necessary, for some flights are restricted or confidential, or in an even higher classification. Flights were then selected. Parallel flights thirty to fifty miles apart are best, with some cross flights for checking. The location of every tenth picture was transferred from the index and marked on an aeronautical chart of the same scale, using a light table. After receiving the pictures, only every fifth or tenth one was examined carefully as the pictures are taken with at least 60% overlap on the verticals and increasingly more on the side pictures. The features were sketched upon the aeronautical sheet with such annotations as: D = dendritic, P = plateau, M = matureland,

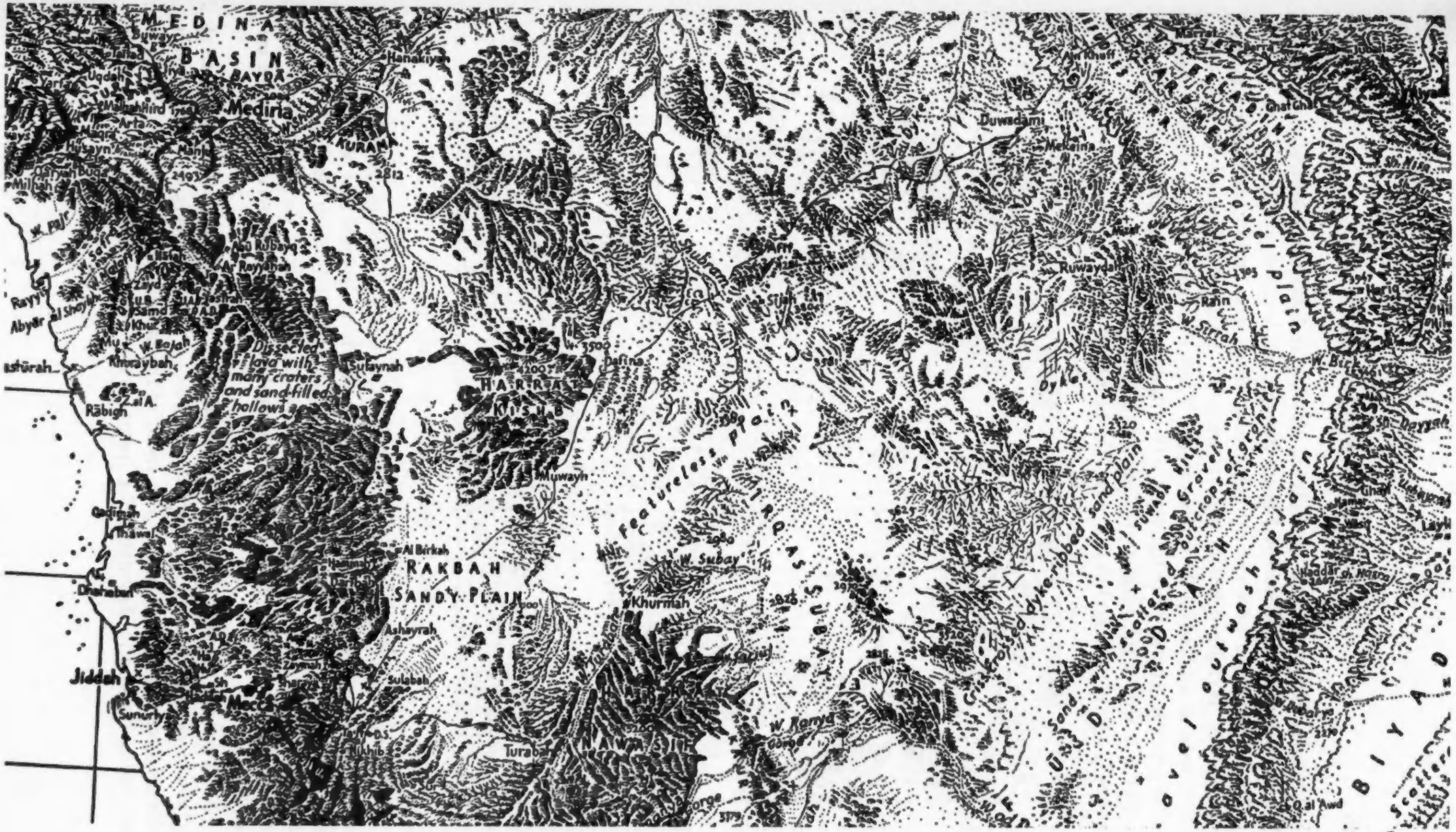

Fig. 2. Part of landform map of Arabia.

H = hamada, Gnp = gneissic peneplane, Fl = featureless, etc., adding new terms wherever desirable as shown by Figure 3.

Quite often there were not enough rivers, roads, etc. on the aeronautical charts to locate the intricate detail of desert features. Using the location of individual photographs as marked on the index maps, a rough triangulation is perfectly possible and of enough accuracy for the scale. It is also possible to prepare a transparent templet to lay over the photograph and locate features that way, assuming that the country is a level plain and the airplane flies at 20,000 feet with not much tilt or crab.

FIG. 3. Annotated aeronautical chart.

The templet in Figure 4 can be used to a distance of twenty miles where the earth's curvature (minus refraction) is only 230 feet; beyond that it is better to measure the distance of the feature below the apparent horizon line and use the scale in Table I. If the tilt of the plane is less than 2.7° or if the feature is within two inches of the center of the picture, the mistake from either source will not exceed 5%.

Another way to obtain a rough approximation of the distance is by the rate of regression of the feature in successive pictures. Farther objects will reappear in more pictures than nearer ones. The speed of the plane as shown by the indexes is remarkably constant. Assuming, for instance, ten pictures taken in twenty miles

of flying, a feature to remain in ten successive pictures has to be twenty miles away (17.3 miles perpendicularly to the flight), while a feature ten miles away will disappear in five pictures.

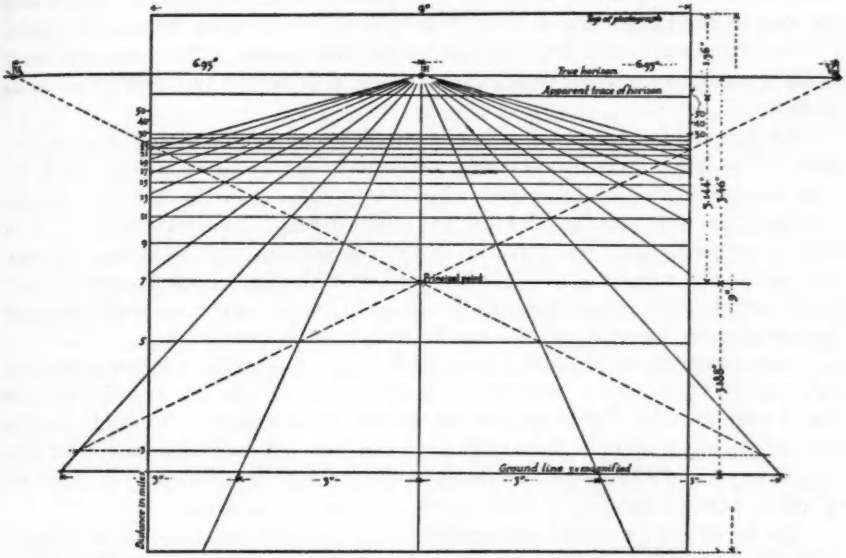

FIG. 4. Templet for location of objects on a trimetrogon side picture from 20,000 feet. Grid lines represent two-mile squares. (Constructed by Edward S. Wood, Jr.)

These methods are crude, but usually the error in indexing the location of the photo in unmapped country is a much more serious source of error. The indexer is not to blame because he tied his index to known points from earlier maps that are often wrong. Mistakes of even fifty miles in the Sahara are not uncommon. The purpose of the landform map, however, is to give an idea of the type of country

TABLE I

Distance of objects in miles, by measuring how far they appear below the visible horizon trace. Object has to be within two inches of center, and the horizon trace has to be within one inch to 1.7 inch below the top of the photo.

Distance of object below the trace of horizon	Distance from plane in miles
1.14 inches	20
0.82 "	25
0.65 "	30
0.53 "	35
0.43 "	40
0.36 "	45
0.30 "	50

rather than the exact location of every hill. Hence the results are not invalid. After seeing the same set of hills from several directions with desert visibility to fifty miles, one secures a fairly accurate idea of their location. It would, of course, be better to place the pictures under an "Oblique Sketchmaster," but this would take too long as one has to look at about 8,000 pictures for an area the size of Arabia.

Annotated maps were only one part of the information. Then came the study of topographic and geologic maps, travel reports, and the like, and further notations were made.

For pen and ink rendering, a base of parallels and meridians on a suitable projection was laid out on Strathmore paper usually one and one quarter times the scale of publication size, or about 1 : 3,000,000. Then came the task of designing symbols to be shown on the 1 : 4,000,000 landform map. This was not easy. It is hard to symbolize features which are commonly known, such as mesas, canyons, etc., but how is it possible to symbolize a hajara which few people have ever seen? Even the finest pen is inadequate to do justice to the delicacy of some of the desert features, and in the reduction to a smaller scale much is lost.

One cannot help thinking that it would be better to work on a larger scale, such as 1 : 1,000,000 or even 1 : 500,000. A landform map is infinitely more informative than a contour map; it looks much more like the actual country. It would be of the greatest benefit if every 1 : 1,000,000 sheet were worked over by a competent geomorphologist and a landform map drawn on the same scale. This project, however, would require the services of trained men, now hardly available.

But we should go even a step further. The landform map shows only geomorphology (with cities, roads, railways, etc. added), but the airplane photos give vegetation and cultivation also. In the same operation these could be annotated or sketched in too. By overprinting the black-and-white landform maps with green, yellow, and brown vegetation and cultivation symbols, we would arrive at a "land-type" map, the true portrait of the face of Mother Earth, and we would more nearly close the altogether-too-large gap between country and map.

To prepare a set of 1 : 1,000,000 land-type maps of all lands of the planet would be one of the most portentous projects of the Air Age, and the need for it is so great that sooner or later it inevitably will be done.

CHINESE CITIES: NUMBERS AND DISTRIBUTION*

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THERE is no possibility of presenting a highly accurate account of the number of cities in China, together with their populations, or even to estimate the total urban population of China. Any figures dealing with the numbers of Chinese cities and their individual populations are at best only estimates taken from a variety of sources, most of which cannot be counted upon as being highly reliable.

One of the first attempts at a listing of Chinese cities, together with their populations, was contained in the publication, *The Christian Occupation of China,* Milton E. Stauffer, editor, Shanghai 1922, Appendix G. Three hundred seventy cities with populations over 25,000 are listed by name and a population estimate given for each. According to the above source there were 69 cities which had a population of over 100,000 or greater, and 186 with a population of 50,000 or more. The list of

Number of cities in each size class, 1922[1]

Number of Cities	Size Class
2	1,000,000 or more
8	500,000–1,000,000
14	250,000– 500,000
13	150,000– 250,000
32	100,000– 150,000
117	50,000– 100,000
56	40,000– 50,000
128	25,000– 40,000
370	

cities and their individual population estimates were the result of a post-card questionnaire sent to missionaries in every mission station in China. Estimates received in this way were carefully compared with estimates previously published in Custom's reports, guide books, atlases, lists of large business houses, Mission Board Reports, Police Commissioners' Reports and others, and a number of changes were made. The list of cities and their population estimates as printed were therefore as com-

* The present study of Chinese cities and a second study, Chinese Cities: Origins and Functions (which is to appear in the March 1952 number of the *Annals*) are in the nature of a preface to what was planned to be a more ambitious undertaking involving field work in China. A Fulbright grant, with supplementary funds provided by the Social Science Research Council, would have made possible extensive field studies in China in 1948–49. Civil War, and the eventual establishment of the Communist regime throughout China, made a use of these research subsidies impossible. The present paper has been written from notes accumulated in library investigations intended as background for the anticipated field studies.

The work was supported in part by a grant from the Special Research Fund of the University of Wisconsin.

[1] Milton E. Stauffer, ed., *The Christian Occupation of China.* Appendix G., lxxxviii–lxxxix.

plete as direct correspondence with local residents and reference to all available printed sources of information at the time made possible. The Survey Committee warned, however, that the list of cities was by no means complete and that many of the population estimates of individual cities were wide of the mark. No claim for a high degree of accuracy was claimed; it was, however, the best that could be done at the time. There were no maps or tables showing distributions.

A second and later attempt at listing Chinese cities and their populations was made by Boris P. Torgasheff in a paper entitled, "Town Population in China," published in the *China Critic,* III, April 3, 1930: 317–322. Torgasheff made considerable use of Stauffer's 1922 data but later estimates were used when they were available. This later list contains the names of 290 cities with a population of 50,000 or more (Stauffer indicated 186) and 112 whose populations exceeded 100,000 (Stauffer indicated only 69). Only the 112 cities with populations of 100,000 or more are listed by name with individual population estimates. The source of information for each city's population is shown in each case and alternative estimates are likewise included. Torgasheff estimated there was a total of 467 cities having a population of 25,000 or greater, while Stauffer's comparable list contained only 370. The combined populations of these 467 cities was estimated to be 50,301,500. Torgasheff believed his list of cities with a population of 100,000 or

Number of cities in each size class, 1930[2]

Number of Cities		Size Class	Total Population
a.	112	100,000 or more	30,880,400
b.	178	50,000–100,000	11,356,400
c.	177	25,000– 50,000	8,064,700
	467		50,301,500

more was relatively complete, although the population figures for the individual cities were probably less accurate. He was of the opinion that his totals for the smaller cities might be far from accurate. For example, he expressed the opinion that the number of cities in class b (50,000–100,000) was very likely between 400 and 500 although his table indicated only 178. There was no attempt to show city distribution.

The first treatment of Chinese cities and their distribution by a native of China, of which I am aware, is contained in a paper by Professor Shen Ju-Sheng, "The Distribution of the Cities of China" (in Chinese), *Journal of the Geographical Society of China,* IV, 1937: 915–935. Only cities with 50,000 or more population are included in this study. A feature which distinguished it from its two predecessors is that it contains a map and tables showing the distribution of cities in China. Shen's list of cities with 50,000 population or more contains 193 titles (186, Stauffer; 290, Torgasheff). For each of the 193 cities listed, precise population figures are given. The latter are estimates from a variety of sources over a considerable range of years, many of the estimates going back to 1922 and making use of Stauffer's figures.

[2] Boris P. Torgasheff, "Town Population in China," *China Critic,* III, 1930: 317–322.

Number of Cities in Each Size Class, 1937[3]

Number of Cities	Size Class
5	1,000,000 and more
5	500,000–1,000,000
19	200,000– 500,000
48	100,000– 200,000
116	50,000– 100,000
193	

Distribution of Chinese Cities by Terrain Classes[4]

Type of Terrain	Sizes of Cities: 1,000,000 and over	500,000–1,000,000	200,000–500,000	100,000–200,000	50,000–100,000
Flat Plains	4	3	11	20	52
Undulating Plain and Hill Land	1	2	8	21	50
Plateau	0	0	0	5	7
Mountains	0	0	0	1	7
Total	5	5	19	47	116

The above table, taken from Shen's article, shows that nearly 47 per cent of the cities of China are located on flat plains, usually deltas and flood plains, while another 43 per cent are on rolling plains and in hilly land. Significantly only 78 out of Shen's 193 cities with populations of 50,000 or greater are serviced by rail transportation. This stands in great contrast to the situation in the United States where it is impossible to conceive of a city growing to a size of 50,000 without the benefit of railroad service. Out of a total of 116 Chinese cities with populations between 50,000 and 100,000 only 36 are located on rail lines. Six others in the 200,000 to 500,000 class, and one in the 500,000–1,000,000 class have no rail connections.

Cities Classified as to Location with Respect to Means of Transportation[5]

	Sizes of Cities: Over 1,000,000	500,000–1,000,000	200,000–500,000	100,000–200,000	50,000–100,000	Total
On railroad	5	4	13	20	36	78
On river	4	3	14	28	53	102
On coast	3	2	4	9	7	25
On main road or highway	5	4	16	38	99	162

The only government document, of which I am aware, dealing with numbers, populations, and distribution of Chinese cities is one prepared by Sun Ming-Hsien and C. C. Fu entitled *Chinese Cities* and published as a pamphlet in 1948 by the Ministry of Interior, Nanking. Sun and Fu list 177 cities with populations of over

[3] Shen Ju-Sheng. "The Distribution of the Cities of China" (in Chinese). *Journal of the Geographical Society of China,* IV, 1937: 915–916.

[4] *Ibid.,* p. 918.

[5] *Ibid.,* pp. 919–920.

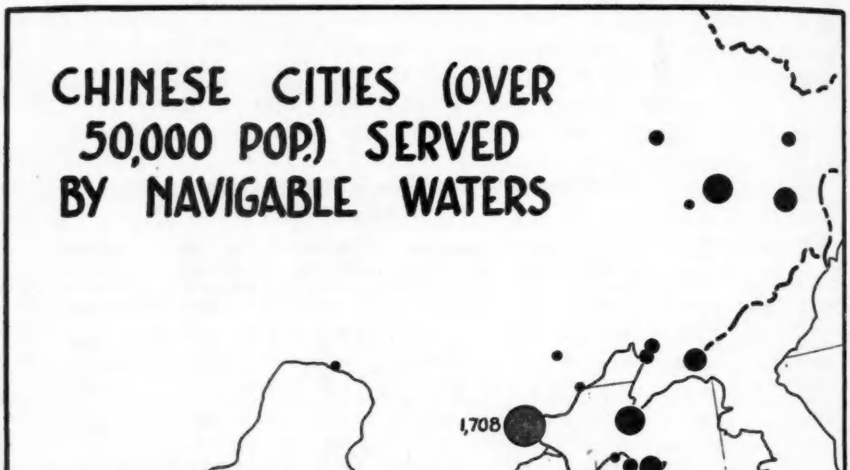

FIG. 1. Approximately two thirds of the cities of China are located on navigable waters. The concentration is much higher in South China than in North China.

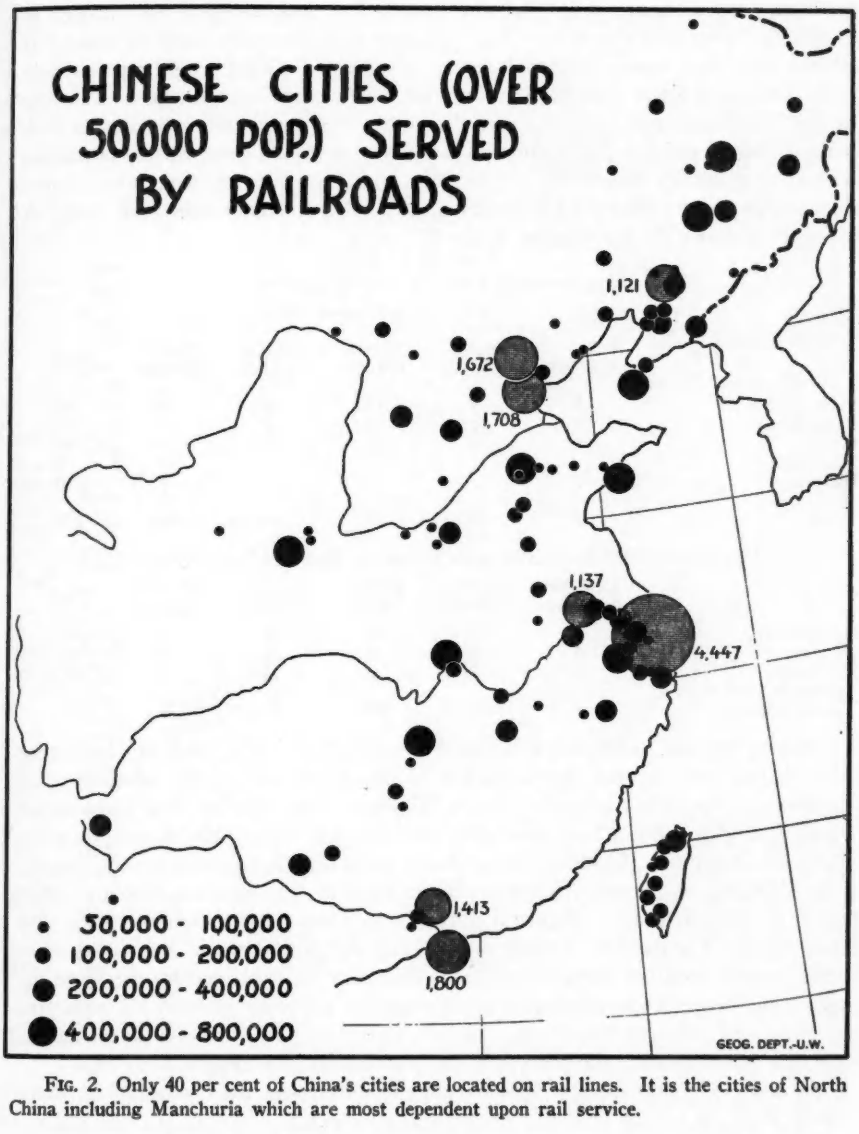

FIG. 2. Only 40 per cent of China's cities are located on rail lines. It is the cities of North China including Manchuria which are most dependent upon rail service.

50,000, the smallest number of any of the four sources mentioned. Moreover Sun's and Fu's postwar figure of 177 includes nine in Formosa, a region not included in Stauffer's, Torgasheff's or Shen's lists. If these nine were subtracted in order that all four lists shall cover comparable areas, Sun's and Fu's list would number only 168. This is 18 fewer than on Stauffer's list which is the next smallest. Like the earlier lists, Sun's and Fu's also give the names and population estimates of each of the 177 cities noted. The population estimates are from a great variety of sources with dates that vary from 1922 to 1947. In general the data are from later sources than is true of the earlier lists, a great majority being for dates later than 1935. A folded map shows the distribution of the 177 cities.

Distribution of Cities by Terrain Classes[6]

Type of Terrain	Sizes of Cities					
	Over 1,000,000	500,000–1,000,000	200,000–500,000	100,000–200,000	50,000–100,000	Total
Plain	5	4	12	30	38	89
Basin	1	2	1	2	10	16
Hills	1	4	10	16	29	60
Mountains	..	..	..	..	2	2
Plateaus	..	..	2	1	7	10
Total	7	10	25	49	86	177

Cities Classified as to Location with Respect to Means of Transportation[7]

	1,000,000 and over	500,000–1,000,000	200,000–500,000	100,000–200,000	50,000–100,000	Total
On railroad	6	9	20	31	33	99
On river	4	6	18	31	50	108
On coast	2	5	2	11	5	25
On motor road or other main highway	7	10	23	42	76	158

Making full use of Shen's, and also Sun's and Fu's tables, and supplementing their sources with several others, but principally, *Handbook of the Administrative Regions of China,* (in Chinese), Chinese Ministry of the Interior, The Commercial Press, Shanghai, 1947, I have been able, with aid of I. Yuan Shie, to compile a list of 216 Chinese cities (including Hong Kong and those on Formosa) with populations of 50,000 or greater. Whether this is more or less accurate than the other lists it is difficult to say. Figure 3 purports to show the distribution of the 216 cities contained in the list. Recent estimates of the populations of individual cities varies greatly even for the metropolises. This may be explained by the large increases and decreases in population experienced by a number of cities through prewar, war, and post-war migrations. In part, also, it may be attributed to the confusion that exists between the concept of the political and the geographical city.

In order to make the five lists of Chinese cities, and their populations more

[6] Sun Ming-Hsien and C. C. Fu, *Chinese Cities* (in Chinese). Ministry of the Interior, Nanking, 1948, p. 7.

[7] *Ibid.*, p. 8.

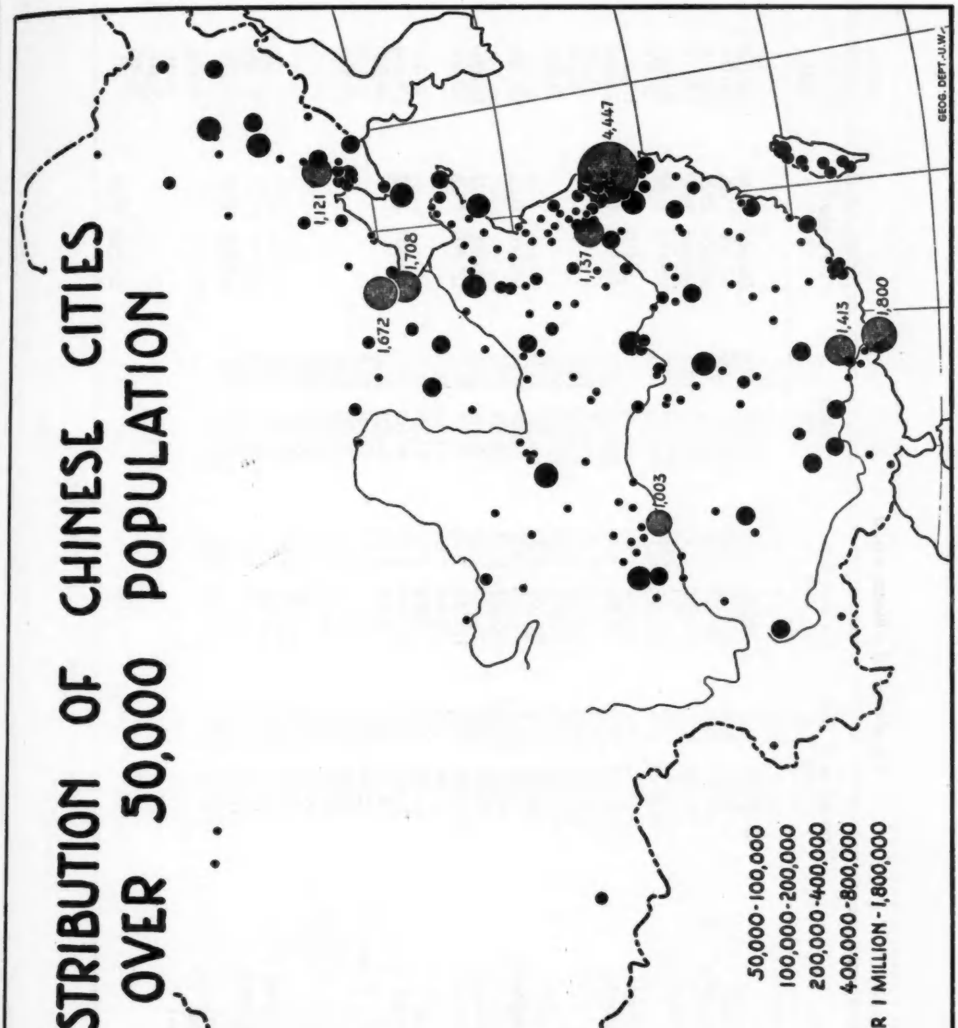
DISTRIBUTION OF CHINESE CITIES
OVER 50,000 POPULATION
4,447
1,121
1,708
1,672
1,137
1,413
1,800
1,003
50,000-100,000
100,000-200,000
200,000-400,000
400,000-800,000
OVER 1 MILLION-1,800,000
1,800
GEOG. DEPT.-U.W.

FIG. 3.

Population of Chinese Cities

Province		City	Trewartha & Shie 1949		Fu and Sun 1948		Shen 1937		Torgasheff 1930		Stauffer 1922
1 Kiangsu											
	1	Shang-hai	4,447,015	1947	4,300,630	1947	3,480,018	1934	2,818,866	1930	1,500,000
	2	Nan-ching (Nanking)	1,137,430	1948	1,030,572	1947	1,013,320	1935	521,700	1929	300,000
	3	Su-chou (Soochow, Wu-hsien)	389,797	1936	389,797	1936	389,797	1936	350,000	1928	600,000
	4	Wu-sih	272,209	1936	272,209	1936	272,209	1936	900,000	1930	150,000
	5	Chen-chiang (Chinkiang)	216,781	1937	216,781	1937	204,723	1936	146,700	1928	260,000
	6	Ju-kao	183,268	1935	183,268	1935	183,268	1935			50,000
	7	Tung-shan (Süchow)	160,013	1935	160,013	1935	160,013	1935	125,000	1928	125,000
	8	Chiang-tu (Yangchow)	127,392	1938	127,392	1938	137,735	1936	300,000	1928	300,000
	9	Nan-t'ung	133,326	1935	133,326	1935	133,396	1935	150,000	1926	65,000
	10	Chang-shu	102,734	1935	102,734	1935	102,734	1935			88,000
	11	Yen-che'ng	102,036	1935	102,036	1935	102,036	1935			90,000
	12	Hai-men	100,572	1935	100,572	1935	100,572	1935			
	13	Sung-chiang (Sungkiang)	67,000	(1937)	66,663	1938	98,909	1936	100,000	1922	100,000
	14	Ch'in-gp'u	95,617	(1935)	95,617	1935	95,617	1935			
	15	Huai-yin (Tsingkiangpu)	80,615	1935	80,615	1935	80,615	1935	130,000	1922	130,000
	16	Wu-chin (Changchow)	125,000	1938	125,000	1938	79,196	1935	125,000	1928	125,000
	17	Kuan-yün	73,945	1935	73,945	1935	73,945	1935			
	18	Chia-ting (Kiating)	73,030	1935	73,030	1935	73,030	1935			40,000
	19	Tai-hsien (Taichow)	66,419	1935	66,419	1935	66,419	1935	100,000	1922	100,000
	20	Kao-yu	62,731	1935	62,731	1935	62,731	1935			40,000
	21	Fou-ning (Fooning, Fowning)	62,144	1935	62,144	1935	62,144	1935			40,000
	22	Pao-ying	59,102	1935	59,102	1935	59,102	1935			30,000
	23	Pei-hsin	56,753	1935	56,713	1935	56,753	1935			
	24	I-cheng (Yicheng)	56,632	1935	56,632	1935	56,632	1935			
	25	Shu-yang	54,839	1935	54,839	1935	54,839	1935			
	26	Chiang-yin (Kiangyin)	53,434	1935	54,839	1935	53,434	1935			50,000
	27	Hsing-hua (Hinghwa)	52,724	1935	52,724	1935	52,724	1935			80,000
	28	Huai-an (Hwaian)	51,619	1935			51,619	1935	180,000	1922	180,000
	29	Lien-yün (Linyun)	76,753	1946	76,753	1946					
	30	Su-ch'ien (Sutsien)									65,000
	31	Chin-t'an (Kintan)									50,000
	32	Tan-yang									50,000
	33	Tung-t'ai									50,000
	34	Pingpu							274,500	1928	

Population of Chinese Cities (continued)

Province	City	Trewartha & Shie 1949		Fu and Sun 1948		Shen 1937		Torgasheff 1930		Stauffer 1922
2 Chekiang										
1	Hang-chou (Hangchow)	606,134	1944	606,136	1944	576,048	1935	467,600	1929	650,000
2	Ning-po	249,633	1942	153,395	1946	244,151	1933	212,400	1928	450,000
3	Yung-chia (Wenchow)	153,395	1946	249,633	1942	202,700	1927	202,700	1927	140,000
4	Shaohsing	177,530	1933	177,530	1932	177,530	1933	400,000	1928	400,000
5	Chia-hsing (Kashing)	102,329	1935	102,329	1935	102,329	1935	100,000	1922	100,000
6	Lin-hai (Taichow)	50,000	1922	211,140	1947	50,000	1922			60,000
7	Chin-hua (Kinhwa)	211,140	1947			50,000	1922			50,000
8	Li-shui (Chuchow)	50,000	1922			50,000	1922			75,000
9	Yü-yao	50,000	1922			50,000	1936			40,000
10	Ch'ang-shan	50,000	1922			50,000	1922			50,000
11	Wu-hsing (Huchow)							100,000	1922	100,000
12	Lan-ch'i							200,000	1905	
3 Anhwei										
1	Wu-hu	203,550	1947	203,550	1947	150,411	1933	136,000	1928	175,000
2	Huai-ning (Anking)	121,379	1933	121,379	1932	121,379	1933	111,221	1929	100,000
3	Pengpu (Pengfou)	105,237	1934	105,237	1934	105,237	1934			
4	Po-hsien (Pochow)	80,000	1922	80,000	1922	80,000	1922	100,000	1926	80,000
5	Fou-yang (Yingchow)	50,000	1943	50,000	1932	70,000	1922			70,000
6	Ho-fei (Luchow)	70,000	1934	70,000	1934	70,000	1934			70,000
7	Liu-an	50,000	1922			50,000	1922			50,000
8	Hsüan-ch'eng (Ningkwo)	50,000	1936			50,000	1936			50,000
4 Kiangsi										
1	Nan-ch'ang	203,101	1946	203,101	1946	277,362	1935	480,000	1928	480,000
2	Fou-liang (Kingtehchen)	71,696	1942	71,696	1942	140,274	1934	200,000	1905	
3	Kiukiang (Chiu-chiang)	137,106	1946	137,106	1946	85,161	1935			85,000
4	Ning-tu	60,000	1922	65,000	1922	60,000	1922			
5	Kan-hsien (Kanchow)	58,332	1934	50,000	1946	58,332	1934	200,000	1922	200,000
6	Jui-chin (Juikin)	56,000	1922	56,000	1922	56,000	1922			50,000
7	Nan-ch'eng (Kienchang)	50,000	1922	50,000	1922					
8	Nan-feng	50,000	1922			50,000	1922			50,000
9	P'o-yang (Jaochow)	50,000	1922			50,000	1922			
10	Chi-an (Kian)							120,000	1922	120,000
11	Lin-ch'uan (Fuchow)							100,000	1922	100,000
12	Ch'ien-ch'ang (Kienchang)					50,000	1922			50,000

Population of Chinese Cities (continued)

Province		City	Trewartha & Shie 1949		Fu and Sun 1948		Shen 1937		Torgasheff 1930		Stauffer 1922
5 Hupeh											
	1	Han-k'ou (Hankow)	749,952	1948	641,513	1947	781,508	1935		1927	350,000
	2	Wu-ch'ang (Wuchang)	174,367	1946	174,367	1946	433,890	1935	1,583,900	(Wuhan)	250,000
	3	Han-yang	137,241	1934			137,241	1934			150,000
	4	Sha-shih (Shasi)	113,526	1931	113,526	1931	113,526	1931	190,000	1928	87,000
	5	I-ch'ang (Ichang)	107,940	1931	107,940	1931	107,940	1931	110,000	1928	60,000
	6	Lao-ho-ko'w	100,000	1922	100,000	1922	100,000	1922	100,000	1922	100,000
	7	Fan-ch'eng	65,000	1922	65,000	1922	65,000	1922			65,000
	8	Chiang-ling (Ching-chou)	50,000	1922	50,000	1922	50,000	1922			60,000
	9	Wu-hsüeh	50,000	1922	50,000	1922	50,000	1935			50,000
6 Hunan											
	1	Ch'ang-sha	421,616	1946	421,616	1946	479,570	1935	535,800	1928	229,537
	2	Hsiang-t'an	82,589	1943	82,589	1943	122,976	1933	300,600	1926	180,000
	3	Heng-yang	181,424	1946	181,424	1946	102,107	1935	100,000	1922	100,000
	4	Ch'ang-te	96,790	1935	50,000	1947	96,790	1935	300,000	1926	180,000
	5	I-yang	80,000	1922			80,000	1922			80,000
	6	Shao-yang (Pao-ch'ing)	75,945	1935			75,945	1935			90,000
	7	Ching-shih (Tsingshih)	58,000	1922			58,000	1922			58,000
	8	Li-hsin-tien	53,746	1933			53,746	1933			
	9	Lei-yang	53,414	1933			53,414	1933			
	10	Yüan-chou (Chih-chiang)									50,000
7 Szechwan											
	1	Ch'ung-ch'ing (Chungking)	1,002,787	1946	1,002,787	1946	281,272	1934	624,300	1928	525,000
	2	Ch'eng-tu	620,302	1946	620,302	1945	480,821	1936	700,000	1926	500,000
	3	Tzu-liu-ching	291,791	1945			100,000	1922	100,000	1926	
	4	Wan-hsien	59,864	1942	60,000	1942	201,839	1931	200,000	1926	110,000
	5	I-pin (Suifu)	76,354	1946	76,354	1946	78,231	1935	150,000	1926	125,000
	6	Lu-hsien (Luchow)	73,515	1935	50,000	1946	73,515	1935			80,000
	7	San-ta'i (T'ung-ch'uan)	70,000	1922	70,000	1945	70,000	1922			
	8	Lang-chung (Paoning)	70,000	1922			70,000	1922			70,000
	9	Ta-hsien (Suiting)	70,000	1922			70,000	1922			70,000
	10	Lo-shan (Kiating)	60,000	1922			60,000	1922	150,000	1926	60,000
	11	Nan-ch'ung (Shunking)	53,478	1935			53,478	1935	120,000	1922	120.000
	12	Ta-chu	50,000	1922			50,000	1922			50,000
	13	Kuang-an	56,000	1945	56,000	1945					

Population of Chinese Cities (continued)

Province	City	Trewartha & Shie 1949		Fu and Sun 1948		Shen 1937		Torgasheff 1930		Stauffer 1922
14	Sui-ning	50,000	1922			50,000	1922			50,000
15	Wu-sheng	50,000	1922			50,000	1922			100,000
16	Fou-chou (Fou-ling)					60,608	1935	100,000	1926	100,000
17	T'ung-ch'uan									70,000
18	Ting-yüan									50,000
19	Kweichow									50,000
8 Fukien										
1	Fu-chou (Foochow)	318,075	1946	300,337	1946	359,205	1935	379,446	1929	625,000
2	Hsia-men (Amoy)	214,580	1946	124,075	1946	196,084	1935	300,000	1928	114,000
3	Nan-p'ing (Yenping)	53,445	1944	53,445	1944	130,000	1929	200,000	1905	
4	Tsingkiang	50,311	1944	50,311	1944	75,000	1922			
5	Chien-ou (Kienning)	60,000	1922			60,000	1922	200,000	1905	60,000
6	Ning-te	60,000	1922			60,000	1922			60,000
7	Lung-ch'i (Changchow)	56,000	1922	56,666	1944	56,000	1922	500,000	1905	56,000
8	Lien-chiang (Lienkiang)							250,000	1905	
9	Ch'ung-an							100,000	1905	
9 Kwangtung										
1	Kuang-chou (Canton)	1,413,460	1948	960,712	1946	1,156,786	1935	829,500	1929	1,600,000
2	Hong Kong (Br.)	1,800,000	1946	1,800,000	1946	754,080	1934	874,420*	1925	
3	Macao	170,000	1948	170,000	1948	190,300	1928	190,300	1928	80,000
4	Shan-t'ou (Swatow)	146,864	1946	146,864	1946	189,996	1935	125,000	1928	80,000
5	Ch'ao-an (Chaochow)	179,068	1935	179,068	1935	179,068	1935	300,000	1926	250,000
6	Nan-hai (Fatshan)	163,314	1931	163,314	1931	163,314	1931	450,000	1928	450,000
7	Ch'ao-yang	127,714	1935	127,714	1935	127,714	1935	250,000	1926	100,000
8	Hsin-hui (Sunwui)	93,048	1935	93,048	1935	92,730	1935	200,000	1928	200,000
9	Mei-hsien	92,730	1935							
10	Ho-p'o	80,000	1922	80,000	1922	80,000	1922			
11	Kityang	65,335	1943	65,335	1943	80,000	1922			80,000
12	Shekki (Shih-chi)	60,000	1948	60,000	1948	79,680	1933	100,000	1922	100,000
13	Huang-kang (Ungkung)	70,000	1922	70,000	1922	70,000	1922			70,000
14	Kao-yao	56,000	1922			56,000	1922			
15	Chukiang (Shiuchow)	207,610	1935	207,610	1935			120,000	1922	120,000

* Includes Kowloon.

Population of Chinese Cities (continued)

Province	City	Trewartha & Shie 1949		Fu and Sun 1948		Shen 1937		Torgasheff 1930		Stauffer 1922
16	Kongmoon (Chiang-men)					93,048	1935	168,000	1922	168,000
17	Hsiao-lan (Siulam)							140,000	1922	140,000
18	Ta-liang (Taileung)									87,000
19	Lien-chou (Limchow)									80,000
20	Shih-lung (Sheklung)							100,000	1926	28,000
21	Kuang-chow-wan							211,006	1926	
22	Sanshui							100,000	1926	
23	Kao-yao (Shiuhing)									56,000
10 Kwangsi										
1	Nan-ning (Yung-ning)	202,720	1946	202,720	1946	88,852	1936			50,000
2	Ts'ang-wu (Wu-chow)	206,986	1946	206,986	1946	82,399	1936			80,000
3	Kweiling	142,202	1946	142,202	1946	74,791	1936	150,000	1907	60,000
4	Liu-chou	208,447	1946	208,447	1946					60,000
5	Yü-lin (Watlam)	50,000	1945	50,000	1945					50,000
6	Kuei-p'ing (Sunchow)									60,000
11 Yunan										
1	K'un-ming	255,462	1945	255,462	1945	143,700	1934	170,000	1926	100,000
2	T'eng-ch'ung (Tengyüeh)	82,951	1934	82,951	1934	82,951	1934			44,400
3	Ko-p-ing	50,000	1922	50,000	1922	50,000	1922			
4	Chao-t'ung	50,000	1944	50,000	1944					25,000
5	Kokiuchang									50,000
12 Kweichow										
1	Kuei-yang (Kweiyang)	262,740	1946	262,740	1946	116,574	1935	100,000	1926	80,000
2	Tsuni	72,321	1944	72,321	1944	70,000	1922			70,000
3	An-shun	50,000	1944	50,000	1944					30,000
13 Hopeh										
1	Pei-p'ing	1,672,438	1946	1,672,438	1946	1,564,869	1935	1,369,400	1929	850,000
2	T'ien-ching (Tientsin)	1,707,670	1946	1,707,670	1946	1,067,902	1935	1,391,721	1929	900,000
3	Ch'ing-yüan (Paoting)	130,000	1947	130,000	1947	312,000	1928	312,000	1928	100,000
4	T'ang-shan	149,124	1935	149,124	1935	85,000	1922	100,000	1929	85,000
5	Shih-men	217,327	1935	217,327	1935	70,000	1922			
6	Lin-yü (Shanhaikwan)	70,000	1922	70,000	1922	60,000	1934			70,000
7	Ch'in-huang-tao (Chinwangtao)	100,000	1947	100,000	1947					

Population of Chinese Cities (continued)

Province		City	Trewartha & Shie 1949		Fu and Sun 1948		Shen 1937		Torgasheff 1930		Stauffer 1922
14 Shantung											
	1	Ch'ing-Tao (Tsingtao)	759,057	1946	759,057	1946	527,150	1935	317,800	1928	90,000
	2	Chi-nan (Tsinan)	591,490	1946	591,490	1946	437,438	1935	300,000	1922	300,000
	3	Wei-hai-wei	222,247	1946	222,247	1946	199,983	1935	160,000	1926	
	4	Chi-ning (Tsining)	150,000	1936	150,000	1936	150,000	1936	200,000	1922	200,000
	5	Yen-t'ai (Chefoo)	139,512	1934	139,512	1934	139,512	1934	102,200	1927	100,000
	6	Lin-i (Ichow)	100,000	1922	100,000	1922	100,000	1922	100,000	1922	100,000
	7	Wei-hsien	82,781	1934	82,781	1934	82,781	1934	100,000	1922	100,000
	8	Chu-ch'eng	80,000	1922	80,000	1922	80,000	1922			35,000
	9	Hwang-hsien	80,000	1922	80,000	1922	80,000	1922			80,000
	10	I-hsien (Laichow)	80,000	1922	80,000	1922	80,000	1922	100,000	1926	80,000
	11	T'ai-an	79,803	1934	79,803	1934	79,803	1934			40,000
	12	Itu (Tsingchow)	60,000	1922	60,000	1922	60,000	1922			50,000
	13	Chuhsien (Chü-chou?)	60,000	1922	60,000	1922	60,000	1922			60,000
	14	Tengchow (P'eng-lai)	60,000	1922	60,000	1922	60,000	1922			60,000
	15	Chou-ts'un (Chowtsun)	56,620	1934	56,620	1934	56,620	1934			75,000
	16	Chiao-chou (Kiaochow)	50,000	1922	50,000	1922	50,000	1922			50,000
	17	Lin-ch'ing (Lintsing)	50,000	1934	50,000	1934	50,000	1934			50,000
	18	Tzu-yang (Yenchow)	150,000	1916					100,000	1922	38,000
	19	Wen-shang									50,000
15 Honan											
	1	K'ai-feng	303,422	1936	303,422	1936	303,422	1936	231,400	1929	280,000
	2	Chou-chia-k'ou	200,000	1922	200,000	1922	200,000	1922	200,000	1922	200,000
	3	Ch'eng-hsien (Chengchow)	80,000	1931			80,000	1931	100,000	1926	35,000
	4	Lo-yang (Honanfu)	77,159	1935	77,159	1935	77,159	1935			30,000
	5	Shang-ch'ü (Shangkiu)	70,000	1947	70,000	1947	73,589	1935			
	6	An-yang	60,000	1922	60,000	1922	60,000	1922			
	7	Hsü-ch'ang	50,129	1935			50,129	1935			40,000
	8	Nan-yang	50,109	1935	50,000	1942	50,109	1935			50,000
	9	Kwang-chou (Kwangchow)							100,000	1922	100,000
	10	Chang-te									60,000
	11	Ku-shih									60,000
	12	Kuei-te (Kweiteh)									50,000
16 Shansi											
	1	T'ai-yüan (Yang-ch'ü)	251,566	1946	251,566	1934	139,458	1934	700,000	1926	80,000

Population of Chinese Cities (continued)

Province	City	Trewartha & Shie 1949		Fu and Sun 1948		Shen 1937		Torgasheff 1930		Stauffer 1922
2	Fen-yang	65,000	1922	65,000	1922	65,000	1922			65,000
3	Ta-t'ung	80,000	1947	80,000	1947	50,000	1922			
4	Kweihwating							200,000		
17 Shensi										
1	Hsi-an (Sian)	502,988	1947	502,988	1947	154,541	1936	200,000	1922	250,000
2	Nan-ch'eng (Hanchung)	50,000	1941	50,000	1941	100,000	1922	100,000	1922	100,000
3	Ta-li	80,000	1922			80,000	1922			80,000
4	San-yüan	80,000	1922			80,000	1922			80,000
5	Wei-han	50,000	1922			50,000	1922			50,000
6	An-k'ang (Hingan)	50,000	1922			50,000	1922			50,000
7	Ku-shih	50,000	1922			50,000	1922			50,000
8	T'ung-chou (Ta-li)									80,000
18 Kansu										
1	Lan-chou	156,468	1946	156,468	1947	105,558	1936	110,000	1922	110,000
2	T'ien-shui (Tsinchow)	50,000	1947	50,000	1947	75,000	1922	150,000	1905	75,000
3	Lin-t'an (T'ao-chou)	62,000	1922			62,000	1922			62,000
4	P'ing-liang	55,000	1922			55,000	1922			55,000
5	Wu-wei (Liang-chou)							200,000	1905	40,000
6	Ch'ing-yang (Kingyang, An-Hua)							300,000	1905	
19 Liaoning										
1	Shen-yang (Mukden)	1,120,918	1947	1,094,804	1947	526,879	1936	245,300	1928	250,000
2	Chin-chou	155,435	1946	155,435	1946	125,701	1936	100,000	1921	60,000
3	Ying-k'ou	154,705	1946	154,705	1946	140,875	1936			
4	An-shan	219,715	1946	219,715	1946					
5	Dairen	722,950	1946	722,950	1946	444,666	1936	237,100	1926	
6	P'u-lan-tien	166,809	1936	166,809	1936	166,809	1936			55,000
7	Fu-shun	279,604	1941	279,604	1941	117,699	1936			
8	New-chwang	106,040	1936	106,040	1936	106,040	1936	100,000	1921	80,000
9	Hsin-min	64,723	1936	64,723	1936	64,723	1936			50,000
10	Liao-yang	102,478	1941	102,478	1941	57,370	1936			70,000
11	T'ieh-ling	52,945	1936	52,945	1936	52,945	1936			30,000
12	Pen-c'hi	98,203	1941	98,203	1941					

Population of Chinese Cities (continued)

Province	City	Trewartha & Shie 1949		Fu and Sun 1948		Shen 1937		Torgasheff 1930		Stauffer 1922
19 Liaoning (cont'd)										
13	Hai-ch'eng	51,693	1941	51,693	1946					
14	Lü-shun (Port Arthur)					141,291	1936			
20 Liaopeh										
1	T'ao-nan	56,315	1936	56,315	1936	56,315	1936	118,500	1928	
2	Ssu-p'ing	76,824	1946	76,824	1946					
3	T'ung-liao							123,406	1928	
21 Antung										
1	An-tung	315,242	1946	315,242	1946	194,230	1936	140,000	1926	70,000
2	Tung-hua	81,993	1946	81,993	1946					
22 Kirin										
1	Kirin	239,325	1946	239,325	1946	143,250	1936	100,000	1907	
2	Ch'ang-ch'un (K'uan-ch'eng-tzu)	605,279	1946	605,276	1946					70,000
3	Fu-yü (Hsin-ch'eng)	64,969	1936	64,969	1936	64,969	1936			
4	Shuang-ch'eng	61,618	1936	61,618	1936	61,618	1936			
23 Sungkiang										
1	Mu-tan-chiang	200,319	1946	200,319	1946					
2	Harbin	760,000	1947	637,573	1941	431,250	1936	319,700	1929	200,000
24 Hokiang										
1	Chia-mu-ssu	168,000	1946	168,000	1946					
2	Fu-chin							140,000	1929	
25 Heilungkiang										
1	Chuliangtsun							140,000	1929	
2	Pe-ian	70,032	1946	70,032	1946					
3	Aigun									50,000
26 Nunkiang										
1	Tsitsihar (Lung-kiang)	174,675	1947	174,675	1947	76,101	1936			50,000
27 Suiyuan										
1	Kuei-sui	103,051	1947			83,722	1935			
2	Pao-t'ou	53,228	1946			67,206	1935			

Population of Chinese Cities (continued)

Province	City	Trewartha & Shie 1949	Fu and Sun 1948	Shen 1937	Torgasheff 1930	Stauffer 1922
28 Chahar						
1	Wan-ch'üan (Kalgan)	86,084 1941		144,829 1935		72,000
29 Jehol						
1	Ch'êng-te	60,000 1947	60,000 1947			45,000
2	Fusing	166,186 1941	166,186 1941			
3	Ch'ao-yang					50,000
4	P'ing-ch'üan (Pa-kou)					50,000
5	Chih-feng					100,000
30 Tsinghai						
1	Hsi-ning (Sining)	55,564 1946	55,564 1946			
31 Sinkiang						
1	Ti-hua (Urumchi)	80,000 1945	80,000 1943			60,000
2	So-ch'e (Yarkand)	60,000 1922	507,000 1945			
3	Shu-fu (Kashgar)	50,000 1945	50,000 1945			
4	Ch'i-t'ai (Kitai, Ku-ch'eng-tzu)	50,000 1934				45,000
5	Ho-tien	50,000 1931				30,000
32 Taiwan						
1	Taipeh (Taihoku)	271,754 1946	271,754 1946			
2	Chi-lung (Kiirun)	87,484 1947	87,484 1947			
3	Hsin-chu (Shinchiku)	125,120 1947	125,120 1947			
4	Taichung (Taichū)	142,653 1947	142,653 1947			
5	Chang-hua (Shoka)	57,180 1946	57,180 1946			
6	Tainan	165,329 1946	165,329 1946			
7	Kagi	116,437 1946	116,437 1946			
8	Takao	150,846 1947	150,846 1947			
9	P'ing-tung	106,766 1948	106,766 1948			
33 Ningsia						
1	Ning-tsia					85,000

readily comparable, they have been combined into a single table in which the cities are listed by individual provinces. Two things become clear. First, that identical population figures for individual cities appear in several of the lists. This is particularly true for the smaller cities for which population data are especially unreliable and likewise difficult to obtain. Each author of a later list, when unable to obtain more recent figures, apparently copied from a predecessor's list. A second feature to be noted from a comparison of the lists is that there are wide variations in the figures given for some cities, even the larger ones. In part this reflects actual fluctuations in city populations, especially since 1937, as a consequence of war. In part, also, it suggests that the figures are based only upon estimates of varying reliability with no means of testing the accuracy of any of them.[8]

[8] The newly organized Census Bureau of the Ministry of the Interior gives the following figures for the larger cities of China as determined by the 1947 population census: Nan-ching, 1,037,656; Shang-hai, 3,853,511; Peip'ing, 1,602,234; T'ien-ch'ing, 1,679,210; Ch'ing-tao, 752,800; Ch'ung-ch'ing, 1,000,101; Dairen, 543,690; Harbin, 760,000; Han-k'ou, 749,952; Kuang-chou (Canton), 1,276,429; Mukden, 1,175,620; Hsi-an, 523,183. See D. K. Lieu, *China's Economic Stabilization and Reconstruction*. Appendix I, pp. 144–145.

GEOGRAPHICAL LIMITATIONS TO FOOD PRODUCTION IN THE MONGOLIAN PEOPLES REPUBLIC

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IN the critical political situation in Eastern Asia today, Soviet Russia's control over the destinies of Outer Mongolia raises questions about the nature of Outer Mongolia's value to Russia. This value may be found either in what Outer Mongolia may export to strengthen the economy of Eastern Siberia, or it may be found in the development of an economy within Mongolia that is more self-sufficient and capable of sustaining greater military potential, or in both. In the past, exports of animals and animal products from Outer Mongolia have contributed significant support to the Russian Army in Siberia. It is to Soviet Russia's interest to maximize Outer Mongolia's capacity to export such products. On the other hand, since about 1931 when the USSR began to monopolize Outer Mongolia's trade, it has had to supply the grain deficit of Outer Mongolia formerly supplied by trade with China and Manchuria. It is likewise to Soviet Russia's interest, therefore, to aid the Mongols to acquire self-sufficiency and even to help supply the need in food-short Siberia. Thus, the production of animal and cereal foods in the Mongolian Peoples Republic is of political and strategic significance in the development of interior and northeastern Asia.

In the present study, an analysis is made of the limiting factors in the production of animal and cereal foods. Important in this analysis are the nature of the geographical base for animal husbandry and agriculture, the obstacles in the way of the pastoral and agricultural industries, and the steps taken for the improvement and extension of both. Among the chief obstacles to improvement and extension of animal husbandry is the overstocking of a range with a limited grazing capacity. Hindering the development of cereal culture is the limiting factor of moisture deficiency as well as certain cultural aspects of Mongol life. While the latter may be overcome by a forceful Russian policy, Nature's limitations are not so amenable to removal. The economic and political effects of the changes and improvements made may not be as great, therefore, as Soviet Russia hopes them to be.

THE NATURE OF THE GEOGRAPHICAL BASE

Topography

From an orographical point of view, Outer Mongolia (Fig. 1) as a whole presents a favorable aspect for livestock grazing, its principal industry. In only a relatively small proportion of the land are slopes too precipitous for agriculture or for farming. In the vast area of the Gobi, the plateau surface is level, or very gently undulating. In the easterly section between Kalgan and Ulan Bator there is seemingly

an endless succession of sedimentary basins separated by low mountain masses. In the west the Altai ranges rise in a long chain of fault blocks with their steep front facing Outer Mongolia and sedimentary basins stretch northward from their bases. Between the Tanu Ola and the Altai lie the broad extent of the Khangai Mountains, but this is a maturely dissected and gently sloping range, with the gentler slopes

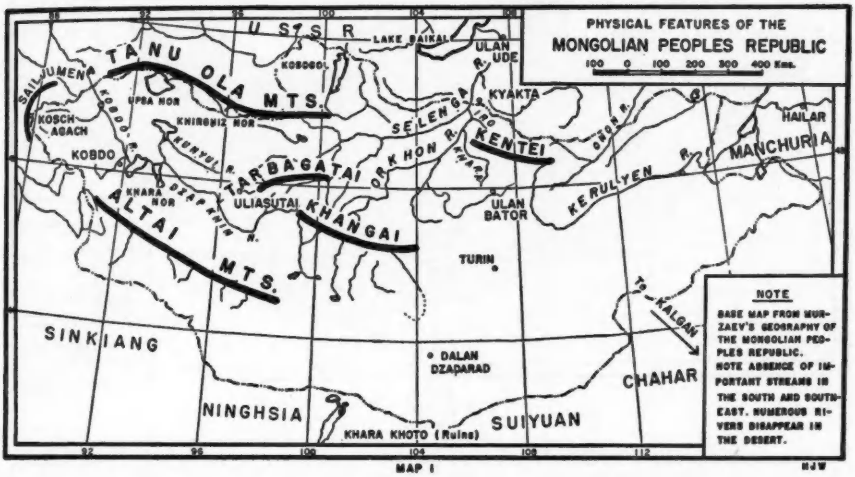

FIG. 1.

stretching northward toward Siberia.[1] Neither the Tanu Ola nor the Kentei appears to present steep slopes except in small areas of the higher altitudes.

Soils

A great variety of soils are shown in Polinova's soil map of Mongolia.[2] The southern half of Outer Mongolia displays an especially complex picture. However, with the exception of the saline and salt-marsh soils, some of the marshy and peaty soils, and the sand, the soils of Outer Mongolia for the most part are not of critical importance in influencing vegetation growth. The amount of precipitation is the principal factor. Were precipitation abundant, the vast area of Outer Mongolia where the surface soils have not been blown away might soon produce lush prairies and forests. However, as Cressey points out, the larger part of the Gobi is covered with a thin veneer of gravel or small stones forming a desert pavement.

Climate

The correspondence of climatic zones and vegetation zones in Outer Mongolia is so close that the map of one might almost be substituted for the map of the other

[1] F. K. Morris, "Notes on the mapping program of the 3rd Asiatic Expedition in Mongolia," *Geographical Review,* XIV (April, 1924) : 288.

[2] See cover map in E. M. Murzaev, *Mongolskaya Narodnaya Respublika.* Moscow, 1948.

(cf. Figs. 2 and 3). The rather widespread impression that the larger part of Outer Mongolia is a vast desert is erroneous. Cressey states that most of the Gobi has a

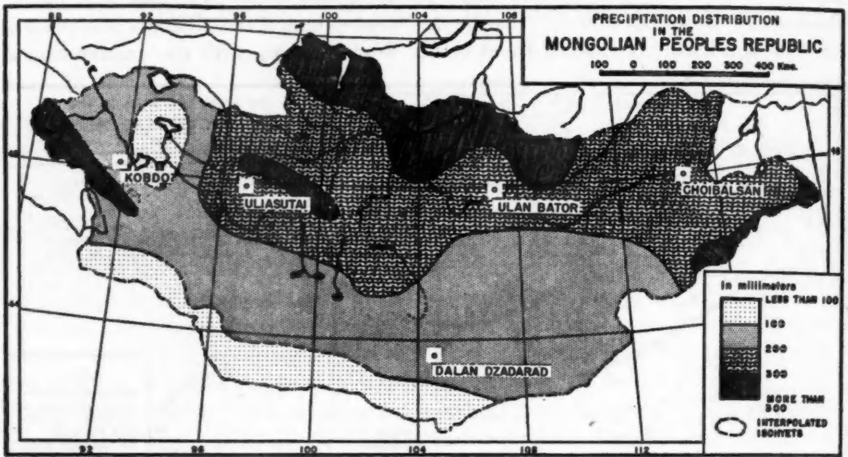

FIG. 2.

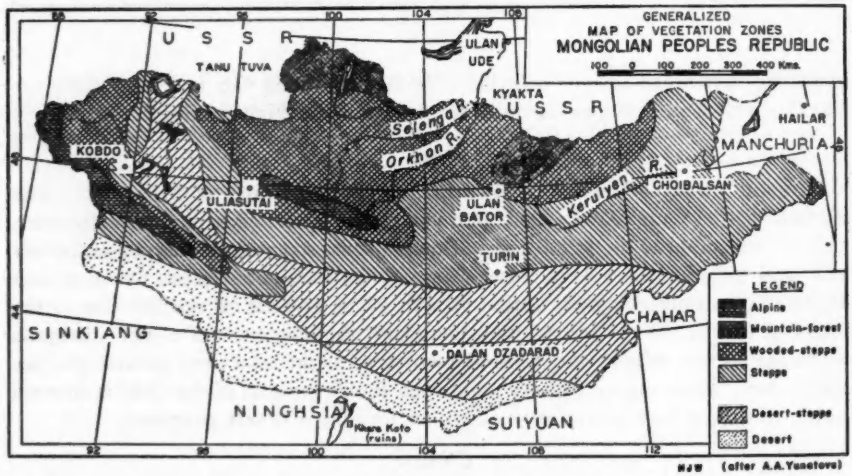

FIG. 3.

BS climate, that of a dry steppe rather than a true desert. The northern hills and mountains appear to be Dw, a cold temperate climate with a dry winter.[3] Larson

[3] G. B. Cressey, *Asia's Lands and Peoples.* New York, 1944. p. 149.

writes that, though winters are severe, they are no more severe than the winters of Montana.[4]

Statistics of climatic elements in Outer Mongolia still are rarely available. Records are restricted to a few stations (see charts of Precipitation Distribution), none of which have had a long history. Some records are available, however, for representative areas. In all areas rainfall occurs mainly in summer. In Kobdo the average annual precipitation is only 3.4 inches. In winter, several months in succession may be without precipitation. The climatic regime is that of a desert.[5] By contrast, in the Selenga River region north of Ulan Bator where agriculture appears most feasible, rainfall is three or four times as heavy, and the lower temperatures reduce the amount of evaporation. The region as a whole receives less than 12 inches. The average annual precipitation at Ulan Bator over a five-year period is given by one source at 8.1 inches,[6] while another[7] states that the annual average here is 9.5 inches. This is about one-third the average at Irkutsk. Increasing distance from the Arctic brings a diminishing amount of moisture, since the Arctic is the source of Mongolia's moisture. There is a marked summer concentration that produces a monsoon-like rainfall pattern. Ulan Bator receives 75% of the year's fall in June, July, and August. Only 9% falls between October and April inclusively.[8]

Vegetation

While the foregoing gives some idea of the limiting factors in food production in Outer Mongolia, an examination of the vegetation is an essential next step. Mongolia is primarily a vast range land, and the grazing potential of land depends fundamentally upon climatic factors which find their best over-all expression in the nature of the vegetation cover. It must be pointed out here and constantly kept in mind, however, that Outer Mongolia is still inadequately surveyed. Much of the statistical information of whatever systematic surveying has been done lies hidden in Soviet Russian files. What little has been allowed to seep out is often highly generalized and occasionally shows discrepancies when compared with previous and outside estimates. Some of the statistics may be unreliable, as there is no way of knowing by what process they were arrived at. Nevertheless, in this study it will be presumed that statistics from recently published books and other documents in Soviet Russia have had the benefit of knowledge of previous data on the subject matter presented.

Roughly speaking, the southern half of Outer Mongolia has precipitation ranging from 3–8 inches, becoming progressively moister with increase in latitude (Fig. 2).

[4] F. Larson, *Larson, Duke of Mongolia.* Boston, 1930. p. 289.

[5] Ch'en, Cheng-hsiang, *Hsi-pei Chü-yü Ti-li* (*Geography of the Northwest Regions*). Chungking, 1945. pp. 181–182.

[6] U. S. Army Air Forces, Weather Division, *Weather and Climate of China, Parts A and B, No. 890.* p. 83.

[7] Ch'en, *op. cit.*, pp. 197–99.

[8] *Ibid.*

The northern half receives 8–12 inches, with the larger amounts in the north central mountains and in small areas in the mountain rim to the far west and far east. Vegetation follows a succession from desert to steppe to forest. Murzaev gives only 14.5 per cent of the country as true desert, while over 75 per cent of the area is covered with some variety of steppe grass. From his percentages in different vegetation types[9] the following table of areas covered by different types of vegetation has been computed on the basis of a total area for the Mongolian People's Republic of 606,000 square miles.

Vegetation type	Percentage of total area	Square miles of each type	Acres of each type	Approx. average annual precipitation in area
Alpine	3.0	18,180	11,639,040	Under 15 inches
Mountain forest	4.1	24,846	15,901,440	" " "
Wooded steppe	25.2	152,712	97,735,680	" 11 "
Steppe	26.1	158,166	101,228,240	" " "
Desert steppe	27.1	164,226	105,104,640	" 8 "
Desert	14.5	87,870	56,236,800	" 4 "
Total	100.0	606,000	387,840,000	

Let us examine some first hand descriptions of the landscape by travelers in different parts of Outer Mongolia. One might well start with the "desert." Andrews[10] states that while it is true that the Gobi Desert is part of Mongolia, only in its western half is it a desolate waste, his being the part lying largely outside of what is now Outer Mongolia. In its eastern part it changes gradually to a rolling plain with "Gobi sage brush" and short bunch grass. In this region there is little water except in surface ponds which are usually dry in summer. Caravans depend upon wells. While the water in the desert contains some alkali, except in a few instances, the impregnation is so slight that it is not especially disagreeble to the taste.[11] The northern edge of the Gobi averages 3,500 feet altitude, and has a stony surface on which coarse grass grows. In the south it descends to 2,400 feet, and is at its lowest level. Here there are large tracts of sand. The surrounding ranges intercept the rainfall, but even the sandy area is not entirely barren; tufts of wiry grass, garlic, and shrubs grow in many spots.[12]

Eastern Mongolia is about equally divided in Yunatovu's map into two zones of vegetation (Fig. 3). These are what he calls "desert steppe" and steppe. According to Obruchev, in eastern Mongolia there are no true deserts. The ground is covered with grass, though sometimes, indeed, so scantily that the soil is visible between the stalks.[13] There is sufficient grass to feed horses and cattle. Between Kalgan and Ulan Bator it is hard to say where the desert ends and where the grass-

[9] Murzaev, *op. cit.*, p. 135.

[10] R. C. Andrews, *Across Mongolian Plains.* New York, 1921. pp. 176–77.

[11] *Ibid.*

[12] Larson, *op. cit.*, p. 291.

[13] M. Obruchef, "Orography of Central Asia," *Scottish Geographical Magazine*, Feb., 1896: 84.

land begins; the transition is imperceptible. But by the time that one reaches Turin at 46 degrees 30 minutes N., one can say the desert is definitely past. South of this area, grass feed is available for grazing animals from June to mid-September in the eastern Gobi. In the winter when the dried vegetation exposes the surface soil, the whole aspect of the country is changed, and it does resemble the popular conception of a desert. Ossendowski was informed by some Tatars that during late winter it was utterly impossible to cross the Gobi with horses owing to the complete lack of grass. Only camels could make the trip.[14] Although middle and southern Mongolia are treeless areas, almost everywhere one has to dig only 20 or 30 feet below the surface to come upon ice-cold water. Even in the Gobi in many places water has been found two yards under the surface of the sand.[15] In the more arid central stretches of Outer Mongolia, xerophytic shrubs are the prevailing forms of vegetation—Ephedra, Caragana, Saltwort, and Wormwood. Grass is much rarer.[16] This condition is found likewise in the western Valley of the Lakes (east of Kobdo).

The 170-mile wide region between Turin and Ulan Bator has been described by Andrews as "glorious rolling hills luxuriant with long sweet grass. . . . I have seldom seen a better grazing country." To his optimistic mind, all that was needed to start a "far-reaching development" was to provide railroad communications through this area.[17] However, his comparison of this area with the prairies of Kansas and Nebraska is hardly accurate. This is Yunatovu's region of "steppe" vegetation. Together with the drier vegetation regions south of it, this strip of steppe, 300 miles broad at the Manchurian border and narrowing to about 60 miles in the western Valley of the Lakes, comprises the southern two-thirds of Outer Mongolia. In the central portion it reaches northward to near Ulan Bator.

Northern Mongolia is richer in vegetation and is the most abundant area for year-round grass feeds. Andrews makes the statement that the prevalence of moisture in one form or another is such that one cannot move on foot in northern Mongolia without a thorough wetting. "When the sun has dried the dew, there are swamps and streamlets in every valley and even far up the mountain slopes. It is the relatively heavy rainfall, the richer soil, and the brilliant sunshine that make northern Mongolia a paradise of luxurious grass and flowers, even though the real summer lasts only from May till August."[18] Trees are seldom seen in Mongolia, but near running water grow such forms as willow, osier, and tamarisk, while on the northern slopes of the mountains in the north appear larches, aspens, and birches.[19] Beginning at Ulan Bator, mountains protected from cutting may have fine forests, such as those on the Bogdo Ula, the most important mountains near Ulan Bator.[20]

[14] F. Ossendowski, *Beasts, Men and Gods.* New York, 1922. p. 85.

[15] Larson, *op. cit.*, p. 292.

[16] Obruchef, *op. cit.*

[17] Andrews, *op. cit.*, pp. 24–25.

[18] Andrews, *op. cit.*, p. 167.

[19] Obruchef, *op. cit.*

[20] Anatolius Markoff, "The towns of northern Mongolia," *Scottish Geographical Magazine*, Feb., 1896: 58–59.

ANIMAL HUSBANDRY: OBSTACLES TO AND STEPS IN IMPROVEMENT

The foregoing discussion has presented the picture of a generally favorable situation for livestock grazing over large areas of Outer Mongolia. Nevertheless, certain difficulties which do not appear on the surface do face animal husbandry in Outer Mongolia. These should be examined to determine the extent of improvement that might be accomplished. Briefly, they relate to winter shelter and suppelmentary feed, increased well facilities, elimination of wild game and harmful rodents, improvement of livestock strains, control of zootics and pests, and perhaps decreased range stocking.

Winter Shelter and Supplementary Feeding

The winter of 1948–49 on the unprotected ranges of Western United States furnishes an example of what can happen to animals in sleet and snow storms. Hundreds of thousands of animals perished from cold and starvation, although power equipment and air drops brought in hay which prevented a major calamity in the livestock industry. While snows are not as heavy in northern Mongolia, the cold is extreme, and even thin snows surfaced with a hard crust of ice prevent animals from getting at the dry grass beneath. Friters tells of one prosperous district in Outer Mongolia where the winter storms and frosts of 1923–24 destroyed all livestock down to the last head. In the winter of 1944–45 unprecedently heavy snows brought death to livestock by the million in Mongolia.[21] In the Djasachto Han district of northwest Mongolia, Larson attributes the small and undeveloped size of the horses to the fact that snows here come early and stay late, and the horses stay undernourished all their lives.[22] The Soviet Russian Scientific Commission sent to Mongolia in 1930–31 found that the primitive conditions under which the cattle live lead to rather large losses in severe winters. Their conclusion was that improvement of these conditions through the provision of sheds or barns, winter feeding with hay and concentrates, and better feeding of calves were essential pre-requisites to further improvement by selection and cross-breeding.[23]

In the United States supplementary feeding was found early to be necessary in many areas to sustain livestock in winter, and by 1900 over 17 per cent of the range livestock were getting supplementary feeding. By 1935 this had been increased to 38 per cent even though the total number of animals using the range had been reduced by several million.[24] Thus, supplementary feeding in winter may improve and save livestock in Mongolia. With this sort of improvement in mind, the Outer Mongolian Government by 1940 had some 250,000 acres of hay under crop cultivation. Further extension of hay land under the Five Year Plan was to provide five tons of hay for every 100 head of cattle by 1952. Furthermore, enclosures, called "khoshans," were constructed to protect cattle. Whether these are something in the

[21] G. M. Friters, *Outer Mongolia and Its International Position*. Baltimore, 1949. p. 12.

[22] Larson, *op. cit.*, p. 171.

[23] O. Kislovsky, "Domestic animals of Mongolia," *Journal of Heredity*, Jan., 1938: 27–32.

[24] Senate Document No. 199, *Letter from the Secretary of Agriculture*. Washington, D.C., 1936, "The Western Range," p. 86.

order of covered sheds is not disclosed, but some 140,000 are claimed to have been built by 1940, enough to accommodate "almost all the cattle of the country."[25] On the other hand, Friters quotes from Murzaev to the effect that by 1945 there were 361,000 "hashiya" (shelters?), "some movable."[26]

Well Facilities

Increased well facilities are important from at least two aspects. First, they increase the area of accessible grazing land by the provision of water where no open water exists. Secondly, by a wider and more even distribution of wells, severe overgrazing in the immediate vicinity of a few wells is reduced. Where wells are few, the herds tend to graze in diminishing amount as the distance from the well increases. While the nutritious vegetation is eaten and trampled near the well, more distant pastures are left relatively ungrazed. Properly spaced watering places for cattle should not be separated by more than five miles on level or gently rolling ranges and by not more than a mile where there are thickets, steep canyons, badlands, and mountains impeding travel. Sheep should travel no more than three or four miles for water in cool weather—half that distance in hot weather[27] Long distance to water areas such as generally prevail in Outer Mongolia cause livestock to walk off their gains in weight.

Andrews tells of seeing thousands of antelope grazing good grassland where there appeared to be no domestic stock. He points out the explanation that the nearest well was twenty miles away. The ability of antelope to graze where horses and cattle cannot is attributable to their lower water-requirement. Thus, grassland with rich fodder might be unavailable to domestic livestock. In Mongolia when the snow melts, the yurts, which often are erected far out upon the plains away from water, are moved near to the wells and to "summer pastures." Sheep do not need water if they can get snow, so that they can reach the grass on the high and dry ridges and distant plains during the winter. On the other hand, in summer the sheep must be where they can water every day; in spring and fall if they have water every other day they can survive.[28] To make up for the insufficiency of wells, the present Mongolian Government claims to have sunk 22,000 wells in the thirteen years from 1932 to 1945, making the total three and a half times the preceding total, or in all, 30,800 wells. This increase may help to account for the increase in total number of livestock of about 2.2 million head from that in 1931 to that in 1941. Another 20,000 wells were to be sunk during the Five-year Plan to be completed in 1952. According to Mandel, there seems to be no fear that this will affect the water table adversely.[29] Information on the distribution of wells is not available except for a limited number of older wells.

[25] F. S. Mansvetov, "Inside Outer Mongolia," *Asia*, May 1945: 246–47.

[26] Wm. Mandel, "Outer Mongolia's Five-year Plan," *FE Survey*, June 15, 1949: 140–41.

[27] B. W. Allred and H. Matson, "Spacing water holes to save grass," *Grass, Yearbook of Agriculture*. U. S. Department of Agriculture, 1948. pp. 236–239.

[28] A. B. Gilfillan, *Sheep*. Boston, 1929. pp. 87–88.

[29] Mandel, *op. cit.*, p. 141.

Game and Rodent Competition for the Range

There are two chief forms of competition with domestic livestock for the use of the Mongolian range. These are wild game, such as antelope, and rodents. Tales by travelers tell of herds of as many as 5,000 head of antelope grazing within the radius of sight in Mongolia. These animals frequently mingle with domestic livestock. While the comparison of wild game in Mongolia with that which once roamed the United States is not on an equivalent basis, some idea of the number grazing Mongolia may be gained when one takes into consideration that an estimated 50 million animal -units once roamed the United States.[30] We may at least conclude that large enough numbers roam the Mongolian range to reduce appreciably the amount of forage available to domestic livestock. And when domestic animals seriously deplete the lower winter grasslands, the wild game is forced into mountain areas which are essentially summer range. This in turn depletes forage for the summer use of domestic stock when the drier plains are scorched and barren.[31]

One of the chief fur and pelt exports of Outer Mongolia is derived from the marmot or ground-hog, an item totaling between 1,500,000 and 2,000,000 pelts annually. It accounts for 70 per cent of the fur export and thus is important in the economy of Mongolia.[32] Nevertheless, this creature is one of the class of rodents which competes with the grazing animals for range land. From the viewpoint of the livestock industry, rodents do a great amount of damage to the range in the destruction of forage. In drought periods, hoarding of grass seeds by rodents brings about critical conditions for the revival and replenishment of the range. As an example, a single Kangaroo rat burrow may contain as much as 50 bushels of grass seed. At times on American ranges there are as many as ten or twelve burrows to the acre. Ground-hogs or prairie dogs in some of the northern Arizona experimental fenced plots have cut down or prevented from growing from 70–100 per cent of certain prominent feed grasses.[33] The huge numbers of such rodents which, moreover, reproduce at a tremendous rate lead to the serious deterioration of ranges in Mongolia.

Wolves

Wolves roam Mongolia in large numbers; annual wolf pelts taken by hunters number some 13,000.[34] They are especially harmful during the winter when the livestock are in a weakened condition and cannot be guarded so closely. Sheep are notoriously susceptible to slaughter, but cattle and horses also are frequently attacked. Larson writes that over all Mongolia horses are run in herds of 200–500, of sufficient size to fight off the wolves that are an everpresent menace.[35]

[30] L. A. Stoddart, *Range Land of America and Some Research on Its Management.* Utah State Agricultural College, Logan, Utah, 1945. p. 9. An animal unit is counted as the equivalent of one cow or five sheep.

[31] Senate Document, *op. cit.*, p. 344.

[32] Friters, *op. cit.*, p. 25.

[33] Senate Document, *op. cit.*

[34] Friters, *op. cit.*

[35] Larson, *op. cit.*

Selective Breeding and Improvement of Strains

Improvement by selective and cross breeding is regarded by Russian experts as an important measure in bringing production of Mongolian animal products to a maximum. All breeds of livestock in Mongolia are of a primitive and unproductive nature.[36] However, all domestic animals of the Mongols except the dog are milked. These include sheep, goats, cattle, yak, reindeer, camels, and horses. Sheep are the most useful of these various animals and make up over 60 per cent of all the animals in number. Except for transportation, they provide the Mongol with almost everything he needs for his simple livelihood. Sheep yield him milk, butter, cheese, and meat for food; wool and felt for clothing, shoes, and shelter; and dung for fuel. Sheep also share the advantage with goats of being small enough to be consumed at one time by the members of an encampment. The other animals are so large that a carcass cannot be eaten at once, and, except in winter, much of the flesh spoils.

Milk yields for all animals are low because the animals need to browse far and wide. Carcasses also have light weights for the same reason, for much of the gains in weight are walked off. Part of this is attributable to inferior breeds, however. Horses are hardly more than ponies, although they are exceptionally hardy and may be very swift. Experiments have been made under Russian guidance to cross the coarse, short-wooled, Mongol sheep with Merino rams, and by 1951 over 1,300 Merino rams had been imported for this purpose. Other experiments involve the cross-breeding of British, mutton type, Romney-Marsh and Shropshire breeds. In cattle-breeding, experiments in the cross-breeding of Brown Swiss and Russian Simmental with the Mongol cattle have been conducted. Crossing of yak with cattle produce good results in offspring, but later generations of hybrids are unproductive. While selective breeding of the various domestic animals of Outer Mongolia will improve the food contribution of the animals to man, the climate is such that Russian breeding experts see the most hope in breeding within the Mongolian types. Improvement on a large scale will be a matter of considerable time and education, and the net increase in productivity cannot be estimated. As previously noted, such improvement must be preceded by the betterment of conditions for survival in the severe winters and on the dry ranges.

Zootics and Pests

Diseases and pests afflicting livestock in Outer Mongolia are responsible for heavy losses. Friters refers to an incident in 1926 where, in one district near the Gobi, 75 per cent of the horned cattle perished from cattle plague. Heavy losses occurred in the spring of 1934 because of a disease epidemic. One of the important innovations introduced by the Russians into Outer Mongolia is that of veterinary stations which in 1939 reportedly serviced some 3,000,000 animals. Sheep dipping was an important aspect of the measures taken.[37] Needless to say, there remains

[36] Kislovsky, *op. cit.*
[37] Friters, *op. cit.*, p. 21.

much to be done in this field to reduce livestock losses. This includes the indoctrination of Mongols to the necessity for preventative measures.

LIMITATIONS OF THE GRAZING CAPACITY OF THE RANGE LAND

While the measures mentioned above are being taken to improve the chances for survival and to improve quality in livestock with a view to increased net output, an important aspect appears to have been left out of consideration in the plan. This is the overstocked condition of the Mongolian range.

In 1921 when Andrews wrote about his expedition into Mongolia, the estimated number of livestock in Mongolia was given by Maiskii at between 12 and 13 million head. This is slightly less than half of the number that roamed the Mongolian plains in 1941.[38] These facts lend some support to Andrews' statement that the livestock at the earlier time was "only a fraction of the numbers which the pasturage could support." However, he is overoptimistic when he says that "indeed, under proper development the pastoral resources of Mongolia are almost unlimited."[39] No doubt, this optimism was derived in part from the fact that huge herds of wild game gave evidence of vast pasturing grounds unutilized by domestic animals.

The use of such terms as "fraction of" and "almost unlimited" are perhaps to be excused in a popular book, but for estimates of the actual animal capacity of the Mongolian range, they are meaningless. Yet in cases where writers have dared to name figures for animal numbers, the optimism has been almost as exaggerated. Maiskii, according to Friters, in 1921 named the figure of 60,000,000 for all types of animals, "if properly organized." Friters himself accepts uncritically the figure of 200,000,000 as "feasible in the long run if military priorities (for the USSR) are reduced and if the veterinary and technical organization keeps in step." He does not examine the capacity of the rangeland, but thinks merely in terms of "the tempo of advance in the future."[40]

At this point we need to understand more clearly what is meant by the vegetation terms used in Murzaev's table of percentages shown in the early part of this discussion. In speaking of grasslands of the temperate zone, Finch and Trewartha discuss "dry deserts"[41] as those regions with under twelve inches of rainfall. On the basis of this classification, all of Mongolia seemingly might be included in the "dry desert" classification, since the rainfall everywhere is under twelve inches and in about three-quarters of the country under about nine inches. However, the effectiveness of the precipitation is a function of evaporation, rate of precipitation, soil structure, and relief as well as of the total amount of precipitation. Cool temperatures in northern Mongolia reduce evaporation, and the relatively level nature of much of the surface reduces runoff. The better vegetated areas, therefore, grow short-grass and bunch-grass and might be permitted in Finch and Trewartha's short-grass category. Nowhere in Mongolia except in restricted meadows and near

[38] *Ibid.*, p. 18.
[39] Andrews, *op. cit.*, p. 177.
[40] Friters, *op. cit.*, p. 20.
[41] V. Finch and G. Trewartha, *Elements of Geography*, 3rd ed. New York, 1949. pp. 437–39.

some streams is there range-grass corresponding to the "tall-grass prairie" vegetation. This is an important limitation upon Andrews' "unlimited" pastoral resources.

Without statistical data for the carrying capacity of the different types of Mongolian grass lands for the different types of livestock involved, we can only reach approximations of this capacity by resorting to a comparative analysis. This is done on the basis of careful studies of similar grassland types in the United States and Canada under a generally similar climate. Areas such as Montana and Alberta Province have the closest degree of similarity.

To dispense first with the obviously unrealistic figure of 200,000,000 head of livestock as a goal, let us assume that all of Mongolia's 606,000 square miles are covered with fine, long, prairie grass in its virgin state. This would provide 387,840,000 acres of lush fodder. Such grasslands, according to the U.S. Department of Agriculture, has a normal capacity of 1.9 acres per animal-unit month or 22.8 acres per animal-unit year.[42] Thus, a little short of five acres of such land per year is required to support a sheep. Therefore, even if all Mongolia were the best of grazing lands, the maximum sustained grazing capacity amounts to some 78,000,000 sheep-equivalents with no extra room for cattle or horses or camels. Even if one allowed double this number of animals to crowd such a range, the total is still far from the 200,000,000 goal. Since Mongolia offers no such lush pastures, we might likewise wipe off Maiskii's "properly organized" goal of 60,000,000 as also being unrealistic, for these include a proportion of cattle, horses, and camels which require several times as much land to support per head as sheep or goats.

A further example to indicate the limited capacity of Mongolian grazing land may be given by noting the number of animals grazing the United States range lands. An estimated 775 million acres of range land in the United States *excludes* what is classified as desert land. These 775 million acres, almost twice the entire area of Outer Mongolia, supported about 20.7 million animal-units in the peak year of 1920. If these animal-units were converted into number of sheep-equivalents alone, the total number of sheep would reach only 103,000,000 head. At this time, furthermore, the United States Western Ranges were heavily overstocked, a condition which was causing a destruction of good grasses and yearly shrinking the available area of good grazing land.[43]

With these general indications of the upward limits of Mongolia's capacity to support livestock, let us next examine what Outer Mongolia actually does promise in sustained carrying capacity. Here we might use Murzaev's highly generalized percentages for different types of vegetation cover and for each type apply the capacity for equivalent vegetation and climatic types in North America. We must note, at least, that American animals, with a larger body size, require proportionately more forage and a somewhat larger area of range per head. However, in our rough comparison, the amount of difference which might be made would not invalidate comparative values.

[42] Senate Document, *op. cit.*, p. 86.

[43] Senate Document, *op. cit.*, pp. 10–11. See also Stoddart, *op. cit.*, p. 20.

Moreover, we may not estimate capacity on the basis of grassland in its virgin condition, since it has been grazed by domestic livestock for many centuries in Mongolia and for about a century in the United States. Under long-grazed conditions, the more nutritive grasses and herbs tend to be reduced or eliminated because of selective grazing by animals, by trampling, and by soil deterioration. In the United States, manuring by animal droppings helps to maintain soil structure and fertility for good grass growth. In Mongolia the droppings for the most part are picked up and burned as fuel, so that there is little return of organic matter to the soil. Under somewhat comparable conditions in Tibet, Kingdon-Ward found that alpine grazing land had been subjected to extensive invasions of inedible or unfavored herbs and weeds because of selective grazing by the yak and because of the extensive burnings of scrub brush and forest to extend the grazing area. He states that it appears probable that unless a change takes place and another succession more favorable to grassland intervenes, these alpine pastures will cease to be grazing ground altogether.[44]

Thus, it appears more reasonable to take as a comparable basis for estimation of grazing capacity in Mongolia the present deteriorated rangeland types of the United States. Also, alpine and mountain-forest grasslands are available during only half a year at most because of the extreme winter conditions, whereas desert and desert steppe grasslands for the most part are available for grazing only during the moister half of the year. Part of the desert steppe may be grazed in the nomadic fashion all the year around, and to make a maximum allowance it will be included here with the steppe and wooded steppe and assumed to be a region of year-round grazing.

Murzaev's veg. type	U. S. equiv. type	Capacity in acres per animal-unit month	Total animal-unit capactiy of veg. type per year
Alpine	(assumed capacity[45] equiv. sage brush grass)	8.9	54,490
Mt. forest	open forest range	5.9	112,290
Wooded steppe	short grass	4.0	2,036,160
Steppe	short grass	4.0	2,108,920
Desert steppe	semidesert grass	6.4	1,368,550
Desert	salt desert shrub	17.5	133,890
	Total capacity in animal-units per year		5,814,300

From the calculation above, it is found that the reasonable capacity of Outer Mongolian grazing lands is about 5,814,300 animal-units per year on the basis of a sustained yield permitting grasses to reproduce satisfactorily. If this sum is converted to sheep equivalents, the total number of sheep comes to 29,071,500.

How does this compare with the actual number of animals in sheep equivalents that now graze Outer Mongolian lands? The latest figures available are for 1941

[44] F. Kingdon-Ward, "Tibet as a grazing land," *Geographical Journal*, July 1947: 73–75.
[45] Senate Document, *op. cit.*, p. 86–107.

when a total of 27,500,000 head of livestock of all types lived off the land.[46] These are broken down into the following categories and numbers:

camels	700,000
horses	2,600,000
cattle	2,800,000
sheep	15,900,000
goats	5,500,000

Assuming that camels, horses, and cattle require five times as much land per head as sheep or goats, the 1941 equivalent amounts to about 50,500,000 head, or some 20,000,000 head more than what might be considered safe stocking without causing serious range depletion. The Mongolian ranges, accordingly, appear to be overstocked about 60 per cent. This compares with overstocking on comparable standards of 17.3 million animal units on a range capacity of 10.8 million animal units in the United States in 1935, or almost 70 per cent overstocking. Of such overstocking practices in the United States, the Secretary of Agriculture wrote: "Even humid pastures could not stand up under such abuse; it is far too much to expect of semi-arid ranges."[47] With Mongolian grasslands being even more arid than those included in United States grazing lands, the Mongolian grasslands no doubt are suffering progressive deterioration. Furthermore, the slower turnover of the animal population on the Mongolian range over that of the American range also indicates heavier demands upon forage by the older animals.[48] Certainly, what Kingdon-Ward says of Tibet may be applied to Outer Mongolia; that is, that without huge supplies of fodder for winter feed, it is probable that these grazing lands are already well-stocked.[49]

While temporary increases in livestock numbers may be pressed upon the crowded pastures, in the long run, this will lead to fewer and scrawnier animals, and to greater mortality among livestock. Annual death losses on overstocked and overgrazed ranges in the United States of as much as nine per cent among sheep and five to seven per cent among cattle are practically double the losses under conservative grazing practices and good feed.[50] What Outer Mongolia needs is a reduction of the total numbers of animals rather than the increased numbers which Soviet Russian planners appear to be trying to impose on this satellite country.

The difficulties in increasing the livestock herds much beyond the presently overstocked numbers is evidenced by the fact that whereas the 1945 goal had been set at 50,000,000 animals of all types, the 1953 goal of the Mongolian authorities reduced the total to 31,000,000. Friters marvels at the fact that in 1930 the number of sheep was over 16,000,000, while eleven years later in 1941 despite Soviet efforts

[46] Friters, *op. cit.*, p. 13.
[47] Senate Document, *op. cit.*, p. 10–11.
[48] *Grass, Yearbook of Agriculture.* U. S. Department of Agriculture, 1948. p. 105.
[49] Kingdon-Ward, *op. cit.*
[50] Senate Document, *op. cit.*

it had dropped to 15,900,000.[51] Although he presents several good reasons partly accounting for this decline, he would not have found this retrogressive situation so "remarkable" if he had realized that the Mongolian grasslands have reached a point of saturation.

POTENTIALS FOR CEREAL CULTURE IN OUTER MONGOLIA

Herding has been the chief source of livelihood of the Mongols in the past, and from it they derive 80–90 per cent of their food. Only about 10 per cent of the Mongol diet derives directly from agricultural products. This situation is not likely to change drastically in the near future. Nevertheless, the drive for increased agricultural production under Soviet prodding in recent decades merits an examination to determine what the agricultural possibilities are in the Mongolian Peoples Republic.

The chief agricultural products used by the ordinary Mongol are cereals, although in the three cities of Mongolia vegetables introduced and largely raised by Chinese also are used to some extent by the Mongol populace. The cereal is used in making "tsamba," a gruel of coarsely ground flour mixed with tea or water and widely used by Tibetans. According to Andrews, however, the Mongols look on "tsamba" only as the means to enable them to carry on until some game or an animal is killed, their ordinary preference in diet being milk and meat products.[52] The Mongols look on agricultural work as degrading. To them digging up the earth not only deprives their livestock of pasture and restricts their freedom of movement in galloping across the country, but also is aesthetically displeasing in that it spoils the beauty of their landscape. This attitude is summed up in the suggestion made to and considered by Genghis Khan that the Chinese in the great North China Plain all should be slaughtered and the land converted into a vast pasture for the Mongol herds. However, the advantages of having a great slave population yielding up riches built upon agriculture tipped the scales against the suggestion. Nevertheless, agricultural work was regarded by them as the work of a lower order of people and below the dignity of the self-respecting Mongol. Only the poorer and more wretched Mongols, such as those along the western borders of Manchuria and the southern borders of Inner Mongolia have felt compelled by lack of animals and pastures to resort to a rather miserable existence in agriculture. An exception is the small tribe of Khodongs, who have a differing cultural heritage.

It is not surprising, then, that sedentary agriculture has not made much progress in Outer Mongolia, and that land put under cultivation in the past has been worked by aliens, largely Chinese and some Russians. Chinese cultivation had brought between 162,000 and 189,000 acres into crops prior to 1912, according to Maiskii, but with the decline of Chinese influence and activity in Outer Mongolia, much of this was abandoned. The presently cultivated areas and the more suitable farming regions of Outer Mongolia are situated mostly in the basins of the Selenga and

[51] Friters, *op. cit.*, p. 18–20.
[52] Andrews, *op. cit.*, p. 153.

Orkhon Rivers (Figs. 2 and 3) where the agriculturalists in 1931 were mainly Chinese and Russians.[53] Mongols engaged in agriculture are found in the western part of the country, chiefly in the Kobdo region. On the western and northern shore of the Kirghiz Nor are a mere 1,500 or so Khodongs, originally a Moslem tribe now converted to Lamaism, whose main occupation is farming.[54] Some farming, mostly by Russians, also was done along the Kiakta-Ulan Bator road in 1921, while in the vicinity of the only three towns or cities, Ulan Bator, Uliasutai, and Kobdo, Chinese gardeners raised a great variety of vegetables under irrigation.[55] It is perhaps the latter type of agriculture that has excited such enthusiastic response in travelers like the explorer Andrews. No doubt a considerable extension of agricultural crops is possible through the construction of expensive irrigation works, but the extent of suitable land for irrigation projects is hard to ascertain without definite survey data, and this is unavailable.

Aside from truck farming, cereals are grown under extensive or dry farming methods, the main crops being wheat, oats, millet, spring rye, and barley.[56] The few statistics concerning land under cultivation and its productivity are confusing and contradictory. The following table is a compilation from various sources and shows the wide differences in figures for the same years.

Year	Cultivated acreage	Source	Metric tonnage of cereals produced	Yield in bushels per acre (calculated)
pre-1912	162–189,000	(Maiskii)	......	......
1929	50,000	(Huang)	......	......
1931	69,300	(Friters)	16,000	8.5
	109,833	(Huang)	......	......
1940	64,460	(Stepanov)	9,015	7.7
	51,285	(Mandel)	......	......
1943	163,000	(Friters)	......	......
1946	......	(Lattimore)	(self-sufficiency 40,000 (?))	4.7 (?)
1947	74,265	(Mandel)	......	......
1948	105,560	(Stepanov)	33,339	11.5

Not only do figures presented in the above table not agree for the same year, but there appears to be an unlikely and great fluctuation in the total acreages cultivated from year to year. These discrepancies lead one to suspect that either the figures are unreliably reported, or that they refer to different categories included. However, where cereal tonnages are reported, they have been given as the amount grown on the acreage reported for the year. The differences in yield then may be attributed to crop and climatic conditions, provided the figures reported are reliable

[53] I. I. Serebrennikov, "The Soviet Satellite, Outer Mongolia Today," *Foreign Affairs*, April, 1931. p. 513.

[54] J. De Francis, *Chinese Agent in Mongolia*. Baltimore, 1949. p. 144.

[55] E. Levakoskaya, "Ancient and Modern Mongolia," *Travel*, Nov. 1939: 45.

[56] Friters, *op. cit.*, p. 30.

and comparable. Let us analyze these figures in greater detail, taking the sources separately.

Friters refers to the Soviet Siberian Encyclopedia for the 1931 acreage of 69,300 which produced about 16,000 metric tons of grain. This was said to be adequate to supply 40 per cent of domestic needs.[57] Both Friters and Eleanor Lattimore[58] quote a figure of about 163,000 acres for 1943 production, attributing their source to Sputnik Agitatora, and Mrs. Lattimore states that by 1946 self-sufficiency had been achieved in cereals.

Some interesting corollaries may be computed if their figures are accepted. Thus between 1931 and 1943 the average annual increase in cultivation amounted to 7,790 acres (although in actuality there probably was an acceleration of the rate of increase with the years). As the production and consumption of vegetables has probably declined in Mongolia since Chinese influence declined, the increased cultivation since 1931 can be assumed to be limited to cereals. Also, if 16,000 metric tons of cereals satisfied 40 per cent of the domestic demand, then self-sufficiency must require a production of about 40,000 tons, provided the population increase has not increased over-all demands. By 1946, therefore, the increased land under cultivation since 1931 of 116,870 acres (assuming a uniform average annual increase in acreage of 7,790) must have brought about the increased production of 24,000 metric tons of cereals, again making an assumption that the previous acreage continued to produce the same average yields. This amounts to some 264 pounds of grain produced per acre, or between four and one half and five bushels per acre, a very low average yield.

Mandel describes agricultural development in terms of the figures of 51,285 acres sown in 1940 and 74,265 acres sown in 1947, but gives no production statistics.[59] On the other hand, Stepanov, writing in a Soviet periodical, quotes both acreages and production figures for 1940 and 1948, citing as his source the Mongol newspaper, Unen.[60] He lists an acreage of 64,560 in cereals for 1940 which reportedly produced 9,015 metric tons of grain (that is, about half of what was produced in 1931 according to the Soviet Encyclopedia), while in 1948 some 105,560 acres produced 33,339 metric tons of grain. On the basis of the 1940 figures, the yield amounts to only 7.7 bushels per acre (using a 60-pound bushel), whereas on the basis of the 1948 figures, the yield per acre is 11.5 bushels. If Stepanov's figures are reliable, 1948 must have been a year of relatively bumper crops in Outer Mongolia, although 11.5 bushels per acre is still a low yield.

The 1948 figure of 33,339 metric tons, however, does not appear to meet the above computed domestic requirements of grain, unless the requirements had been reduced considerably. On the other hand, if self-sufficiency in cereal production

[57] *Ibid.*

[58] E. Lattimore, "Report on Outer Mongolia," *FE Survey,* Nov. 6, 1946: 340.

[59] Wm. Mandel, "Outer Mongolia's Five-year Plan," *FE Survey,* June 15, 1949: 142.

[60] M. Stepanov, "Ekonomicheskoe Razvitie Mongol'skoi Narodnoi Respubliki," *Vneshnyana Torgovlya,* XIX, No. 6 (June 1949): 1–8.

had been reached by 1946, the desire for further increased production would not be urgently viewed by the Mongol government unless external inducements or pressure existed because of Soviet Russian food demands for the expanding Siberian mining and industrial population as well as for the Red Army in Outer Mongolia and Siberia. Let us, therefore, examine the basic possibilities for extensive cereal agriculture in terms of the geographical factors involved.

Chinese travelers in the Mongolian grasslands have been enthusiastic over agricultural possibilities. One avows that at least a million square "li" of land might be plowed.[61] Another claims there are approximately 16,000,000 acres available for farming.[62] The latter roughly accords with Maiskii's estimate of four per cent of the area being suitable, but Maiskii immediately states that there is no scope for agriculture,[63] thereby nullifying the optimistic import of his other statement. His negative evaluation no doubt took into account the climatic situation, which is definitely unfavorable. A short growing season, severe winters, and, especially, low and unreliable rainfall with frequent droughts make farming insecure and difficult. Eck in *Zeitschrift für Geopolitik* asserts that great care in seed selection and the institution of an extensive irrigation system is needed in order to make farming feasible.[64]

Lack of statistical material taking into detailed account combination factors of topography, soils, drainage, and climate makes it impossible even to estimate the actual area feasible for the different forms of agriculture. In the following discussion, therefore, the conditions that need to be met for etxensive wheat culture will be compared with certain general indications of what the reasonable expectations for cereal expansion may be. It appears likely from the mechanical equipment obtained from Soviet Russia by the Mongol state, such as tractors, sowers, and combines, that the experimental agriculture at present is being conducted along extensive lines and concerns chiefly dry-farming.

A number of unfavorable conditions face agricultural development. In the region of the north where moisture is most favorable, the mountain ranges of the Altai and Sayan systems render much of the area topographically unsuitable for cultivation. Soils correspond to those on the Siberian side of the border described by Prasolov as degraded and leached soils of the forest-steppe belt.[65] Large areas of the valleys of the Selenga, Tola, Khara, and Iro Rivers (Fig. 1) in the north are occupied by grey, clayey soils with a shallow depth of from 3–8 inches.[66] Many of the valley bottoms in the moister northwest and north central parts of Mongolia are

[61] De Francis, *op. cit.*, p. 153.

[62] Huang Chiu-sheng, *Pien-chiang t'un-keng-yuan shou-ts'e* (*A Handbook of the Frontier Settlement Region*). Chungking, 1944. p. 77.

[63] Friters, *op. cit.*, p. 30–31.

[64] H. Eck, "Die Äussere Mongolei als Sowjetrussisches Kolonisationsobjekt," *Zeitschrift für Geopolitik*, 1937, Jan.–June: 373–74.

[65] L. I. Prasolov, "The climate and soils of northern Eurasia as a condition of colonization" in *Pioneer Settlement*. New York, 1932. pp. 244–45.

[66] N. Vargin, *Mongolskaya Narodnaya Respublika*. Moscow, 1949.

marshy and have poor drainage. Relative humidity for this area also is low, the average for the year at Ulan Bator being 68 per cent; that for the three months of spring only 56 per cent; and that for summer months 62 per cent.[67] The mean summer temperature, however, does not constitute one of the critical limiting factors for wheat cultivation in Outer Mongolia; at Ulan Bator the July average is 62° F. compared to the northern cold limit for wheat of 57° F. for the mean summer temperature. The growing season, while short and subject to occasional summer frosts, is sufficient, being 134 days at Ulan Bator.[68] Such varieties of wheat as Garnet and Reward grown in Canada will ripen in a little over a hundred days.

The principal limiting factor for wheat and other cereal culture in Outer Mongolia, aside from those of terrain and soil, is that of the amount of moisture available to the plant during the growing season. In this, both the seasonal distribution of rainfall and the total amount are significant factors. The water requirements of wheat are estimated at four to five inches of rainwater. The actual amount of rainfall, however, must exceed this considerably, owing to evaporation, surface run-off, and downward percolation. In the Merced area of California, wheat has been grown without irrigation where the rainfall is 10.3 inches per year. This is contrasted with the much larger amounts seemingly necessary in the Great Plains region where in the same latitude the margin of cultivation was on about the 19-inch isohyet. On the other hand, wheat was grown with even more scanty rainfall in Russian Turkestan where over a ten-year period the average rainfall annually in the Sir Daria, Fergana, Samarkand, and Trans-Caspian provinces amounted to only about 8.3 inches. This, however, is truly marginal cultivation, and the yield could not be counted on.[69] Any drop below the average rainfall produces partial or complete crop failure, since only about half the annual rainfall here actually is obtained by the plants. As in these areas of semi-arid climates great fluctuations occur in rainfall, droughts are frequent. The distribution of rainfall seasonally in Soviet Central Asia also is different from that found in northern Mongolia, for in the former area, the total from May to September is only two inches, or a quarter of the year's precipitation, whereas in northern Mongolia some 75 per cent of the rainfall comes during the three months of summer (Fig. 4).

A better comparison for the northern Mongolian situation is presented by the situation in southern Alberta, Canada. Here, latitude average annual temperature, evaporation rate, and seasonal distribution of precipitation are more akin to those of northern Mongolia. Olds and Fort Vermilion, Alberta, have mean July temperatures of 60° F. In this area the normal average annual precipitation is between 11 and 12 inches.[70] The margin of precipitation over actual crop needs throughout this area is small during the average season. Agriculture is distinctly marginal here,

[67] U. S. Army Air Forces, *op. cit.*, p. 109.

[68] Ch'en, *op. cit.*, p. 197–99.

[69] J. F. Unstead, "The climatic limits of wheat cultivation," *Geographical Journal*, May, 1912: 423–29.

[70] W. A. Mackintosh, *Prairie Settlement*, Vol. I. Toronto, 1934. p. 194.

and, as the critical annual precipitation stands at 12 inches, so the critical warm season precipitation stands at about 7.5 inches of water.[71] Thus, it is seen from this comparison that the Selenga and Orkhon River valleys where land appears most suitable for farming fall into the category of sub-marginal agricultural lands. In fact, even the rainier mountain regions of the northern border have warm weather rainfalls and annual precipitations barely above the critical margins, so that these lands, too, would suffer frequently from drought with consequent crop failures.

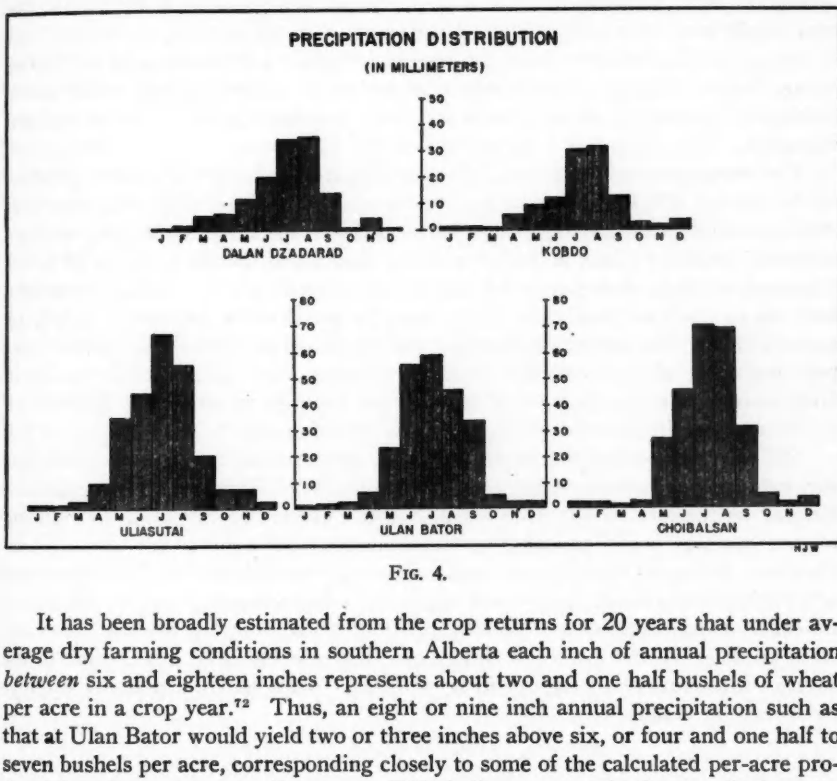

FIG. 4.

It has been broadly estimated from the crop returns for 20 years that under average dry farming conditions in southern Alberta each inch of annual precipitation *between* six and eighteen inches represents about two and one half bushels of wheat per acre in a crop year.[72] Thus, an eight or nine inch annual precipitation such as that at Ulan Bator would yield two or three inches above six, or four and one half to seven bushels per acre, corresponding closely to some of the calculated per-acre productivity given on a preceding page. This indicates not only the marginal nature of production in the past, but also the likely upward limits of per acre production under conditions of extensive cereal culture in the climatic regime of Outer Mongolia.

With these geographical conditions and limitations in mind, there still remain the economic considerations of the agricultural use versus the grazing use of the

[71] *Ibid.*, p. 175.
[72] *Ibid.*, p. 180.

land susceptible to cereal growing. Under Mongol grazing conditions (an overstocking of about 60 per cent), one sheep requires an average of perhaps about three acres per year of the best grazing lands for sustenance, land which might otherwise be put to cereal production in the moister areas in the north. Dry farming practices required under the low rainfall regime would keep about half of the land withdrawn from grazing in fallow, thus in effect halving the yield per acre in terms of the total land kept from grazing. Nor could the land in fallow be grazed, because in order to accomplish the water-accumulation purpose of the fallow, the land would have to be kept cultivated and clear of weeds that might transpire the soil moisture. On the other hand, the removal of grass cover in the semi-arid Mongolian climate with its extremely severe winter winds might also lead to the eolian erosion of the thin soils similar to that which has removed the soil cover in southern Mongolia.

The three acres necessary to sustain a sheep year-round might, therefore, produce on the average only about nine or ten bushels of dry cereals or about 600 pounds of cereals in good years. Against this must be balanced the value of the land in terms of animal products which in one year would amount to the dead weight of about 60 pounds of sheep, three pounds of wool, about two pails of ewe's milk, a sheepskin, and, not to leave out any element of value, an uncalculated amount of argol, or manure fuel.[73] The sum value of these variables in animal products is hard to compute, but to the Mongol with his cultural preference, the difference economically in favor of cereals, if it is in favor of them, is not likely to be such as to incline him voluntarily to shift his occupation from herding to farming.

Still another consideration enters, however, which seems to reduce any advantage that extensive agriculture might possess over herding. This is that the extensive farming on the mechanized scale which Soviet Russians appear to be introducing requires tractors, combines, and other machinery as well as fuel to run them and replacement parts and maintenance costs. It seems doubtful that the low return per acre agriculturally would justify such expenses, unless economical production be not the criterion here in the expansion of cereal culture. By contrast, herding sheep and cattle on these moister lands involves no such expense and little work, while to the Mongol the returns may appear to be of greater value and the pastoral employment more desirable.

CONCLUSIONS

The preceding examination of the nature of the geographical limitations to food production in the Mongolian Peoples Republic seems to warrant certain general conclusions pointing up the difficulties involved.

First, climatic conditions are not favorable for either a greatly enlarged livestock industry or for more agricultural expansion of the extensive type. In the former industry, serious problems must be overcome in the provision and distribution of additional wells, the provision of shelters during the severe winter weather,

[73] Friters, *op. cit.*, pp. 15–16.

supplementary feeding, measures against animal pests, diseases and predatory beasts, and the improvement of strains and breeds. A more serious limitation, however, is that of a deteriorating rangeland already heavily overstocked. An attempt to crowd additional numbers of animals onto this range in the long run will defeat its own purpose by diminishing range capacity.

In the expansion of extensive cereal agriculture, lack of moisture is the primary discouraging factor. Both extensive and irrigation agriculture face obstacles in the Mongol cultural habits. Pastoralism is his cherished mode of life. The Mongols prefer animal foods, traditionally despise agriculture, and oppose the limitations upon the free movement of their herds that agriculture imposes. This attitude, which might be compared to that of the early open range cattlemen in the United States, may be overcome by Soviet pressure over a sufficient length of time if the returns politically and economically appear worthwhile to Soviet Russia. Nomadic pastoralists are difficult to control politically because of the nature of their free movements. The Soviet Government has been exercised to settle the nomadic peoples within the Soviet Union itself to a more fixed mode of agriculture and animal husbandry. This political motive may be as important to the Soviet Union as the economic one in its attempts to stimulate cereal and hay culture among the Mongols.

On the other hand, the production of exportable surpluses of food appears unlikely to keep pace with a population which has an accelerating rate of growth as newly introduced health and sanitation measures and the decline of monastery life combine to decrease the death rate and to increase the birth rate. Even with improvements along the lines indicated in the above discussion, the amount of food products which Soviet Siberia can hope to derive from Outer Mongolia seems limited largely to what surplus it can squeeze from a level of production only slightly higher than that of the present. The conclusion would appear warranted, therefore, that Soviet Russia's interest in Outer Mongolia lies more in the political and strategical benefits than in the economic returns.

REVIEWS AND ABSTRACTS OF STUDIES

THE STUDY OF COLONIES

R. J. Harrison Church: *Modern Colonization.* Hutchinson's University Library, London: 1951.

Within the short space of some 50,000 words and with the aid of 12 maps, Dr. Church tries to cover a field that, in terms of his own definition, is too large to be effectively handled, either as to its concepts or illustrative material. We are disturbed throughout the reading by the repeated statements of aim and purpose, and by illustrations that consistently fail really to hit the target. Chapters deal with the content of the geography of colonization, wherein the author fortifies himself with the concepts and work of French geographers; then the author proceeds to geographical aspects of modern colonization (which is seven pages of historical generalities); and finally the author turns to what he calls the physical geography, social geography, economic geography (with a chapter on transportation), and political geography of colonization. He emphasizes the need for geographical studies in modern colonial areas in an appendix.

Colonial geography, according to French geographers by whom the author is strongly influenced, deals with "the geographical aspects of the contact of different peoples associated by colonization"—and therefore covers all lands and all times. In effect, this embraces the geography of man, with a particular emphasis. Even if applied to "modern" colonization alone, the field embraces permanent settlement, or merely political sovereignty with economic exploitation, or strategic colonization, or the settlement of groups in alien territories like the Germans in southern Brazil. This is far too big a subject for one brief survey. Instead of drawing in cursory references to the history of exploration, the railroad development of Canada, etc., in a few brief paragraphs, the author would have been much wiser to have concentrated his attention quite specifically either on tropical colonization, or, better still, on one area, namely, Africa, for this is the only part of the world on which he has anything of real value to offer.

We are perturbed by the author's basic geographic concepts and by the lack of consistency between his theory and his practice. "The British system of indirect rule not only followed the tradition of laissez-faire and liberalism, but is also a close response to climatic conditions" (p. 27) is a throwback to naive "geographic determinism," for British, French, Belgians, and Dutch have very different concepts of colonial government in tropical lands, as Dr. Church well knows. "Climate, vegetation, and soils have determined or influenced the character of exports" (p. 29) is a statement with the same flavor; nor does the climate of Kenya *cause* white settlers to grow sisal, coffee, tea, and other crops (p. 67). A statement of political geography as "the study of geographical conditions which have influenced the political structures and evolution of territorial units" (p. 105) is outmoded by the (relatively old) concept of Michotte (quoted by Church on p. 13) and by the recent discourse of Hartshorne published in the *Annals of the Association of American Geographers.* Dr. Church is evidently not clear as to what he means by "geographical conditions" or "factors," for he uses geographical as the equivalent of physical; to study the influence of these "factors" on political areas is not the same thing as to study the arrangement of political areas on the earth's surface. Such criticisms have been made *ad nauseam*, but they are obviously still pertinent here since it is essential clearly to fix our sights before we can tackle our problems. Specific problems are most effectively presented in the chapters on transport and on different kinds of frontier problems in the tropics.

What Dr. Church is pleading for is that geography in Britain should find more sponsors and more recognition for research in the colonies and in the training of colonial officials and so in the Universities. On this we are all agreed; this is a great need in all colonial areas and in all backward areas. The lack of recognition is not always because colleagues and prospective sponsors are obtuse. The reason why French geographers, like Robequain, Gourou, and others, command attention is because they have first made intensive "regional studies" of particular tropical areas. We need to be more specific in research proposals and to pay more attention to basic concepts. In both these respects, this book would have been more convincing if it had dealt more specifically with the problems of modern colonization in one part of the modern world.

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